

## Table of contents

Instruction: W0010034

:  
: 0 001 121 ..

Special features	I02/1
Structure, usage	I05/1
General information	I06/1
Safety measures	I08/1
	I10/1
Test values and settings	I16/1
Tightening torques	I18/1
Lubricants	I19/1
Circuit diagram	I21/1
Starting-motor disassembly - tab	I22/1
Component cleaning	II11/1
Testing, repair - table	II13/1
Starting-motor assembly - table	I01/2
Editorial note	A01

Continue: I01

## TABLE OF CONTENTS

Starting-motor assembly table	III18/1
Editorial note	IV28/1

Continue: I01/1

## SPECIAL FEATURES

These instructions describe repair operations for the following pre-engaged-drive starting motors of type DB

- 12 V/1.1 kW

0 001 121 ...

This type of starting motor is fitted with an axial seal in the drive-end bearing and a thrust ring at the collar of the meshing pinion. More recent versions feature a radial-lip-type oil seal in the drive-end bearing and are dealt with in separate instructions.

Continue: I02/2

## SPECIAL FEATURES

A new parts set is always to be used on assembly.

Lubricate in line with lubrication schedule before and during assembly.

Prior to assembly, use three-square scraper to remove all residual paint from fitting and sealing surfaces.

Continue: I03/1

## **SPECIAL FEATURES**

If the starting motor is painted after assembly, make sure that paint does not ingress into the interior of the starting motor through the vent holes.

Seal vent holes before painting.

Always re-open vent holes after painting to ensure proper operation of starting motor.

Continue: I03/2

## **SPECIAL FEATURES**

The overrunning-clutch drive is subject to considerable wear and is always to be replaced.

The bushings in the drive-end bearing and commutator end shield are always to be renewed.

The entire planetary gear train is to be replaced in the event of damage to or impermissible wear on the output shaft of the planetary gear train.

Continue: I04/1

## **SPECIAL FEATURES**

There is no means of checking the solenoid switch which would provide reliable information on long-term trouble-free operation.

It is therefore advisable to renew the solenoid switch when repairing the starting motor.

On installation, approx. 0.5 g of Loctite 577 (5 994 090 000) is to be applied to the threads of the solenoid switch bolts.

Continue: I04/2

## **SPECIAL FEATURES**

Starting motors of this type have various vehicle-specific drive-end bearings which may differ considerably from the version shown. This does not however affect disassembly, testing, repair and assembly.

Continue: I01/1

## STRUCTURE, USAGE

PC user prompting:

Position cursor on button and confirm.

Microcard user prompting:

User prompting is provided on every page e.g.:

- Continue: I 17/1

- Continue: II 18/1      Fig.: II 17/2

Brief instructions may include several rows of coordinates.

I../. = first coordinate row

II../. = second coordinate row

III../. = third coordinate row

etc.

.../1 = upper coordinate half

.../2 = lower coordinate half

Continue: I01/1

## GENERAL

Unless otherwise stated, the voltages indicated in these instructions are DC voltages.

AC voltages are marked by the symbol " \* ".

Continue: I06/2

## GENERAL

Expert repairs are only possible using the prescribed tools and measuring instruments, which are in perfect working order. We therefore recommend that exclusive use be made of the tools listed.

The use of incorrect and unsuitable tools and testers can lead to injury and may damage the product concerned or its component parts.

Continue: I07/1

## **GENERAL**

Some of the tools listed in these repair instructions were originally developed for a different application.

The appropriate instructions are to be heeded when using these tools.

Continue: I07/2

## **GENERAL**

Only use replacement parts given in the service parts list for the starting motor concerned.

Proper functioning presupposes use of the lubricants specified in these instructions, both prior to and during assembly.

Absolute cleanliness is to be ensured when performing repair work.

Continue: I01/1

## **SAFETY MEASURES**

### **Component cleaning:**

Armature, commutator end shield, solenoid switch and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other parts such as planetary gear train (not plastic components) and drive-end bearing can be washed out with commercially available cleaning agent which is not readily flammable. Take care not to inhale vapours. Components must be re-lubricated or re-greased in line with lubrication schedule.

**Continue: I08/2**

## **SAFETY MEASURES**

**Danger of fire:** Take care to avoid naked flames and sparking.

### **ATTENTION:**

Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Always use the listed tools. Injuries cannot be precluded if use is made of incorrect and unsuitable tools and testers.

**Continue: I09/1**



## **SAFETY MEASURES**

**Always heed the following safety regulations:**

- \* German Order governing the use of flammable liquids (VbF).
  - \* Accident prevention regulations for electrical systems and equipment.
  - \* Safety regulations for the handling of chlorinated hydrocarbons:
    - For companies: ZH 1/222
    - For employees: ZH 1/129
- issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

**Continue: I09/2**

## **SAFETY MEASURES**

**Outside Germany, pay attention to appropriate local regulations.**

**Skin protection:**

**To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.**

**Continue: I01/1**

## TESTERS, EQUIPMENT, TOOLS

All tools required for repairing starting motors of type DB are listed in the following.

Some of the tools needed have to be improvised in line with the drawings.

The type designation is given in parentheses for tools which used to be ordered on this basis.

Continue: I10/2

## TESTERS, FIXTURES, TOOLS

Interturn short-circuit  
tester with test probes: 0 986 619 110

Test prods: 0 986 619 101  
(Old version: 0 986 619 114)

Alternator tester  
WPG 012.00: 0 684 201 200  
(alternatively, Motortester)

Magnetic measurement  
stand: 4 851 601 124

Dial indicator: 1 687 233 011

Mandrel press: comm. avail.

Continue: I11/1

**TESTERS, EQUIPMENT, TOOLS**

Clamping support:	0 986 619 362 (KDAW 9999)
Torque wrench (0...70 Nm):	comm. avail.
Torque meter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
Spring balance (2...12 N):	0 986 619 181 (KDAW 9991)
Assembly sleeve:	0 986 619 415
Disassembly sleeve:	0 986 619 416

**Continue: I11/2****TESTERS, EQUIPMENT, TOOLS**

Pressing-on tool for pinion with 9 teeth:	0 986 619 404
Pressing-on tool for pinion with 10 teeth:	0 986 619 405
Holding fixture:	0 986 619 420
Collet chuck, comprising * Clamping fixture, body:	0 986 619 408
* Collet chuck for pinion with 9 or 10 teeth:	0 986 619 412

**Continue: I12/1**

**TESTERS, EQUIPMENT, TOOLS**

Brush holder locating sleeve:	0 986 618 134 (KDLJ 6018)
Bushing puller:	0 986 617 243 (KDAL 5493)
Spring collet for bushings diameter 10 mm:	0 986 617 250 (KDAL 5493/0/7)
Pressing-in mandrel:	0 986 617 149 (KDAL 5058)

**Continue: I12/2****TESTERS, EQUIPMENT, TOOLS**

Tailstock chuck with Morse taper 2 for clamping diameter 5...45 mm for holding armature when turning down:	0 986 619 156 (KDAW 9987)
Vernier caliper:	comm. avail.
Three-square scraper:	comm. avail.
Small cape chisel:	comm. avail.

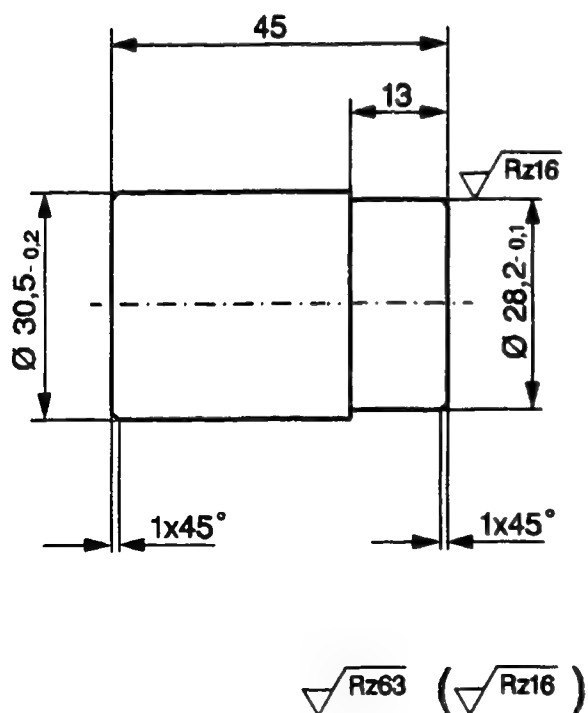
**Continue: I13/1**

# TESTERS, EQUIPMENT, TOOLS

Pressing-out mandrel  
for bushing  
in drive-end bearing: to be improvised

Continue: I14/1 Fig.: I13/2

KMS00454

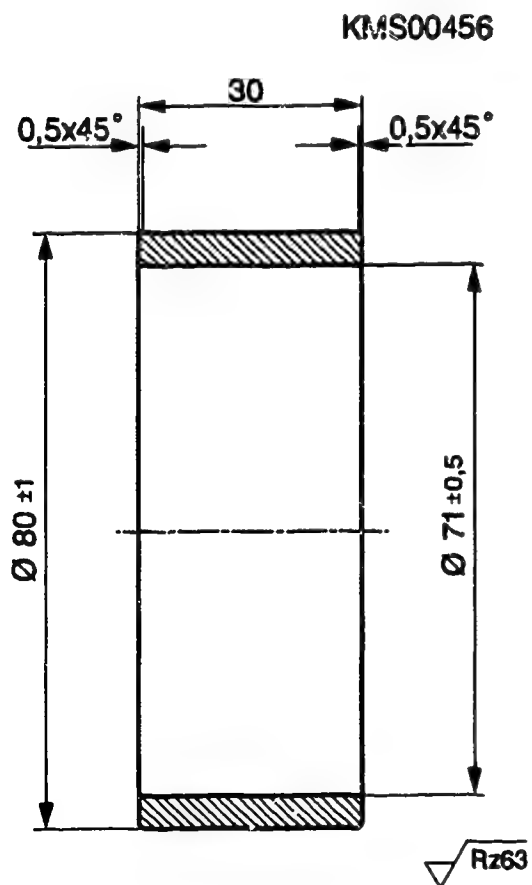


# TESTERS, EQUIPMENT, TOOLS

Support ring for  
stator frame:

to be improvised

Continue: I15/1 Fig.: I14/2



# TESTERS, EQUIPMENT, TOOLS

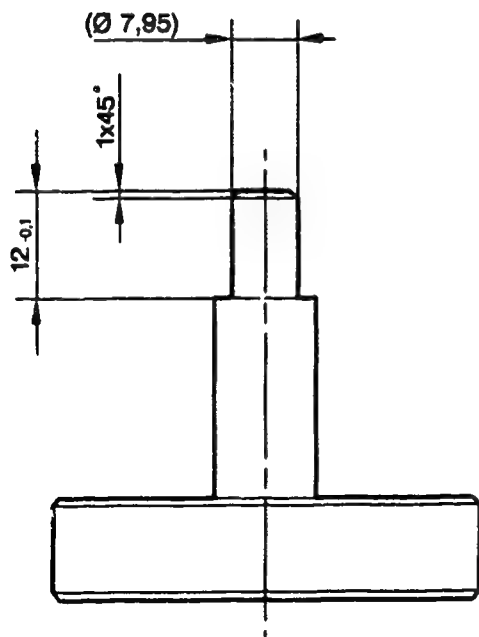
Assembly stand for  
planetary gear train: 0 986 617 138  
(KDAL 5047)  
(reworked version)

## ATTENTION:

The 7.95 mm dia. pin at the assembly  
stand must be shortened to the  
dimension stated on the drawing.

Continue: I01/1 Fig.: I15/2

KMS00289



## TEST SPECIFICATIONS AND SETTINGS

Commutator - minimum  
diameter: 31,2 mm

Radial run-out  
- Commutator: < 0,01 mm

Armat. axial clearance: 0,2...0,75 mm

Continue: I16/2

## TEST SPECIFICATIONS AND SETTINGS

Armature braking torque: 0,7...1,2 Nm

Clutch overrunning  
torque: 0,1...0,2 Nm

Carbon brush  
wear dimension x: < 14 mm

Total pinion travel a: 12...15 mm

Continue: I17/1



# TEST SPECIFICATIONS AND SETTINGS

Solenoid-switch  
pull-in voltage: 5...8 V

## Solenoid-switch resistances

\* For starting motor 0 001 121 002

- Pull-in winding: 0,3...0,4 Ohm

- Holding winding: 1,5...1,9 Ohm

\* For all other starting  
motors 0 001 121 0..

- Pull-in winding: 0,3...0,4 Ohm

- Holding winding: 1,5...1,7 Ohm

Continue: I01/1

## TIGHTENING TORQUES

Attachment of end plate of  
commutator end shield: 1,5...2,0 Nm

Attachment of commutator end  
shield and drive-end  
bearing: 5,5...6,0 Nm

Solenoid-switch  
attachment: 4,5...6,0 Nm

Brush-holder connection,  
term. 45: 7...9 Nm

Connection, term. 30: 7...9 Nm

Continue: I01/1

## LUBRICANTS/LUBRICATION SCHEDULE

### General:

Commutator and carbon brushes are to be kept free of grease and oil.

Greased parts are to be degreased before re-lubricating them.

New bushings must be moistened prior to installation using suitable oil.

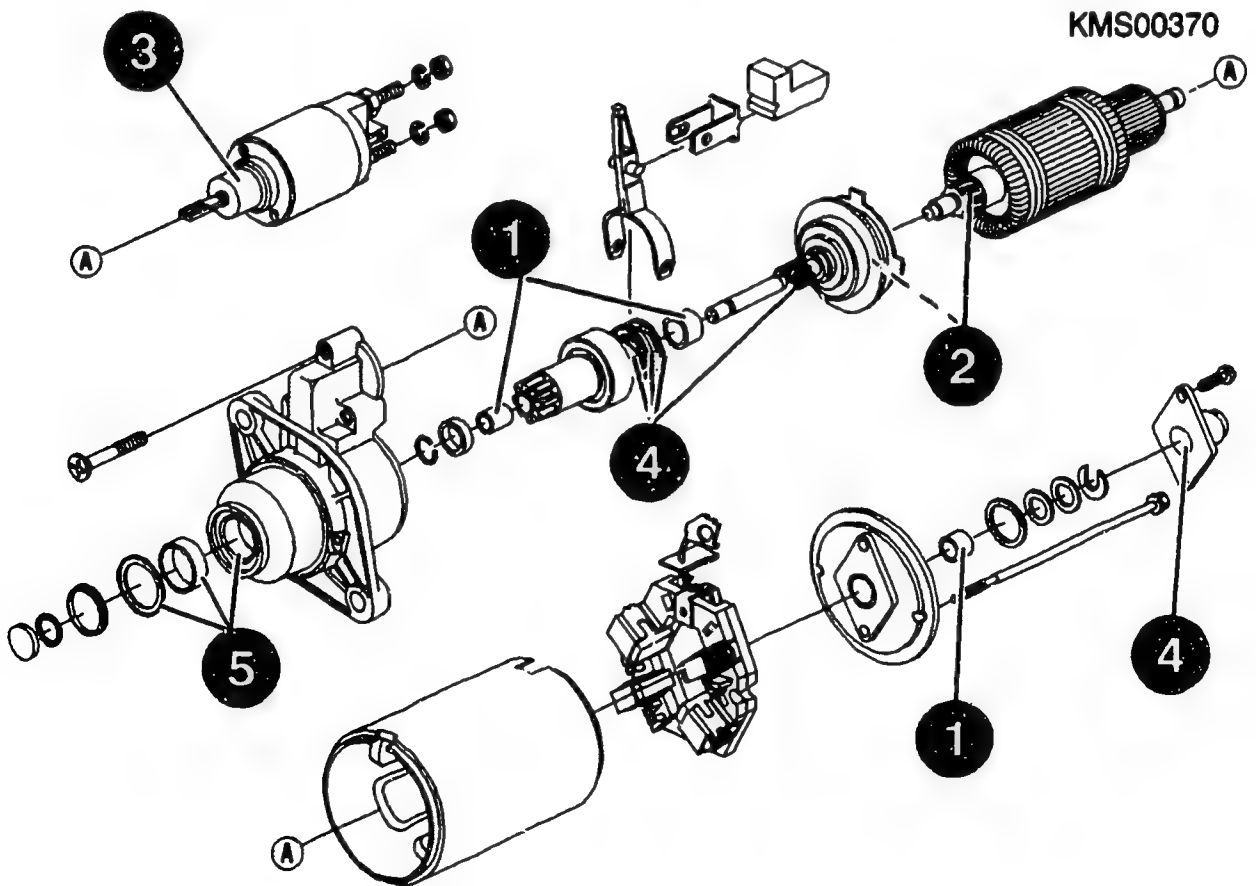
Oil VS 13 834-01: 5 962 260 000

Continue: I20/1

# LUBRICANTS/LUBRICATION SCHEDULE

1	=	Oil	VS	13 834-01	5 962	260	000
2	=	Grease	VS	16069-Ft	5 984	610	120
3	=	Grease	VS	16634-Ft	5 990	260	000
4	=	Grease	VS	18036-Ft	5 997	098	000
5	=	Grease	VS	18099-Ft	5 997	287	000

Continue: I01/1 Fig.: I20/2

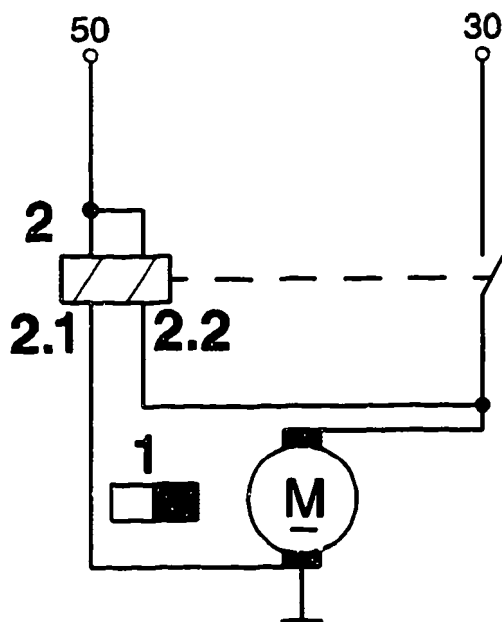


# CIRCUIT DIAGRAM

- 1 = Exciter field (permanent magnet)
- 2 = Solenoid switch
- 2.1 = Holding winding
- 2.2 = Pull-in winding

Continue: I01/1 Fig.: I21/2

KMS00394



**STARTING MOTOR DISASSEMBLY TABLE**

<b>Solenoid switch disassembly</b>	<b>I23/1</b>
<b>Bearing end plate disassembly</b>	<b>I26/1</b>
<b>Commutator end shield disassy.</b>	<b>I27/1</b>
<b>Drive-end bearing disassembly</b>	<b>II01/1</b>
<b>Armature disassembly</b>	<b>II02/1</b>
<b>Planetary gear train and overrunning-clutch drive disassembly</b>	<b>II04/1</b>
<b>Cap disassembly</b>	<b>II07/1</b>
<b>Overrunning-clutch drive disassembly</b>	<b>II08/1</b>

**Continue: I01/1**

# STARTING-MOTOR DISASSEMBLY

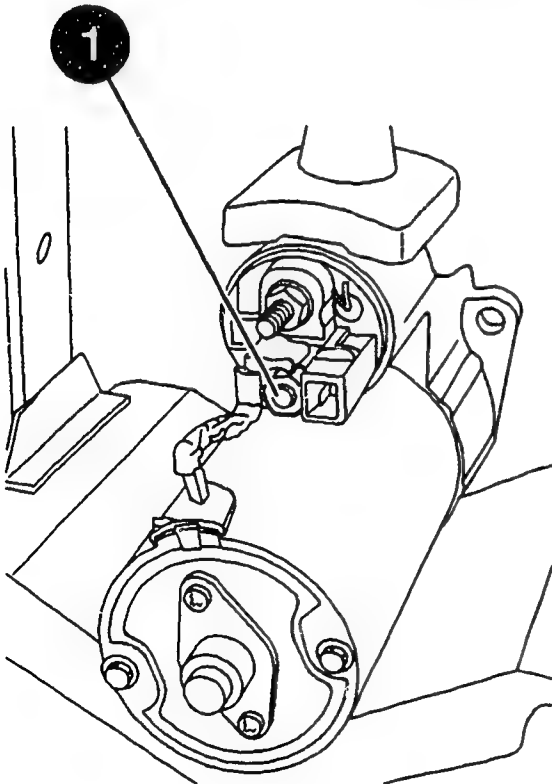
## Solenoid-switch disassembly

Clamp starting motor in clamping support. Unfasten connection (1) of excitation winding at solenoid switch.

Clamping support: 0 986 619 362

Continue: I24/1 Fig.: I23/2

KMS00395



## STARTING MOTOR DISASSEMBLY

### Disassembling solenoid switch

Mark position of solenoid switch.  
Unfasten solenoid switch bolts.

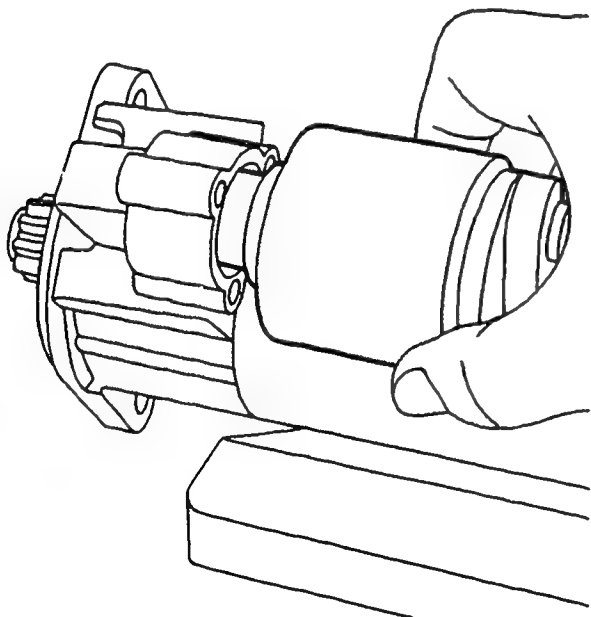
### DANGER OF ACCIDENT

The pretensioned return spring causes the solenoid switch to be pressed down by the switch armature.

Pull solenoid switch off switch armature. Pay attention to return spring in solenoid switch armature.

Continue: I25/1 Fig.: I24/2

KMS00396





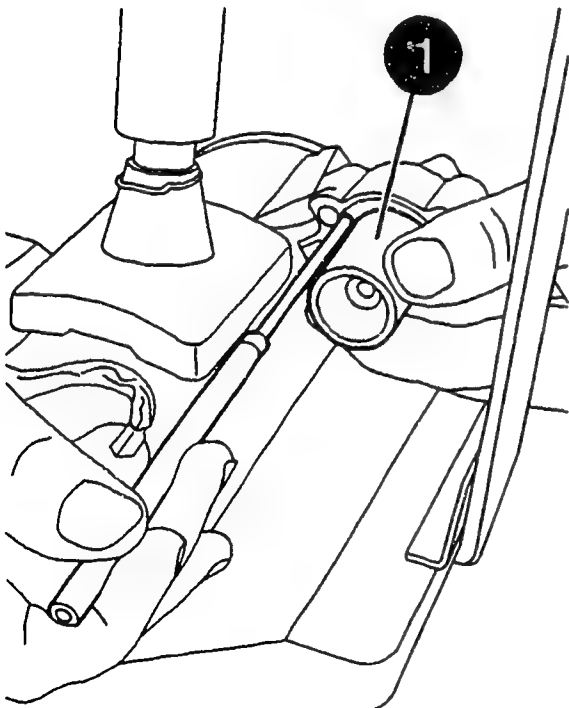
## STARTING MOTOR DISASSEMBLY

### Disassembling solenoid switch

Use suitable tool to pull back engaging lever and disengage solenoid switch armature (1) at engaging lever.

Continue: I22/1 Fig.: I25/2

KMS00397



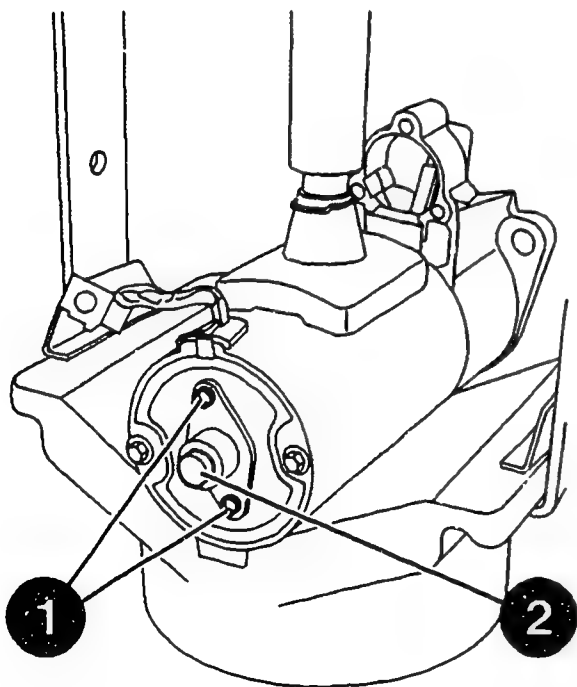
## STARTING MOTOR DISASSEMBLY

### Disassembling bearing-end plate

Unfasten bolts (1) of bearing-end plate (2). Remove bearing-end plate with sealing ring.

Continue: I22/1 Fig.: I26/2

KMS00398



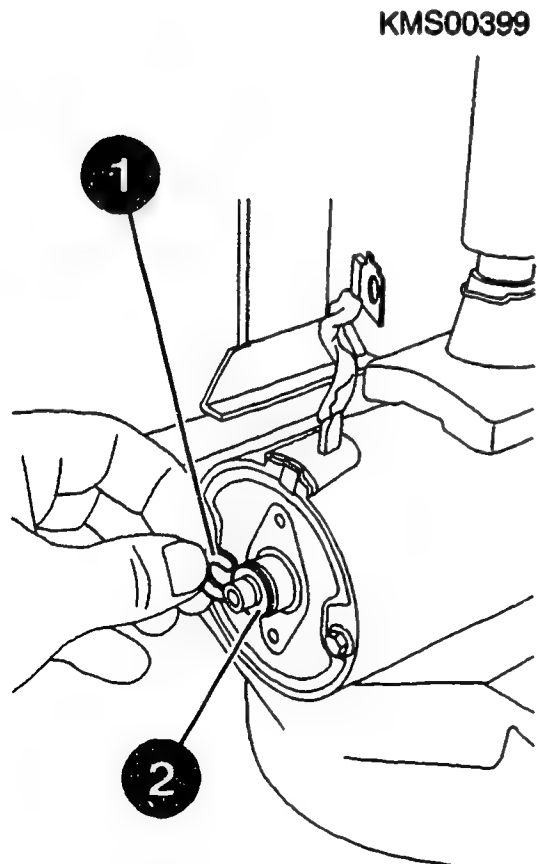
## STARTING MOTOR DISASSEMBLY

### Disassembling commutator end shield

Remove positioning washer (1) of armature shaft and shim (2).

**NOTE:** If there is any burr at the armature shaft groove, start by removing this burr with an oilstone or the like.

Continue: I28/1 Fig.: I27/2



## STARTING MOTOR DISASSEMBLY

Disassembling commutator end shield

Unfasten bolts (1).

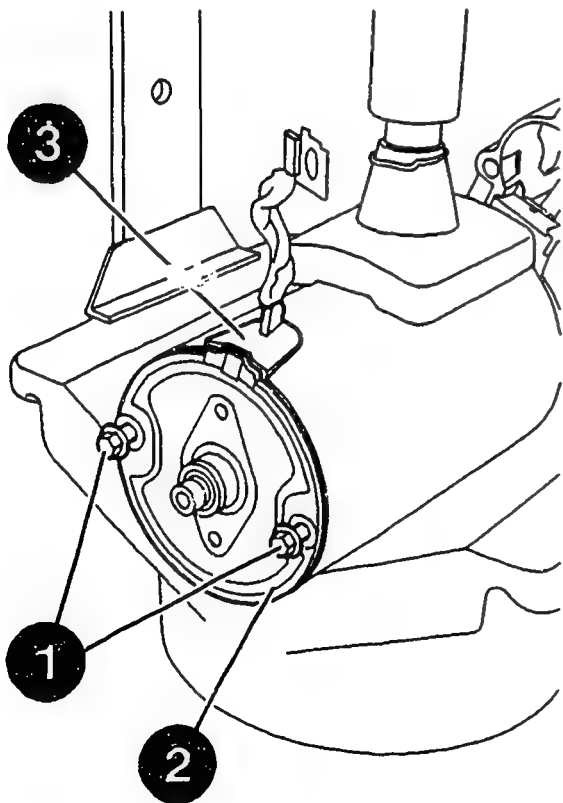
Remove commutator end shield (2) from stator frame, taking care not to damage gasket (3).

### DANGER OF INJURY

The drive-end bearing is not fixed in position with respect to the stator frame.

Continue: I22/1 Fig.: I28/2

KMS00400



## STARTING MOTOR DISASSEMBLY

### Disassembling drive-end bearing

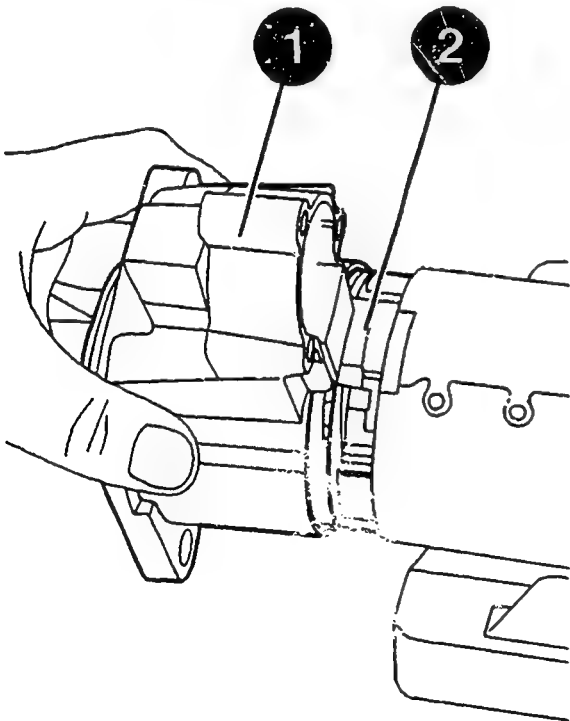
Remove drive-end bearing (1) complete with planetary gear train (2) from stator frame.

Slip assembly horizontally onto assembly stand and move to vertical position so as to avoid damage.

Assembly stand for planetary gear train (reworked version): 0 986 617 138

Continue: I22/1 Fig.: II01/2

KMS00401



## STARTING MOTOR DISASSEMBLY

### Disassembling armature

Attach locating sleeve (1) to armature shaft from commutator end.

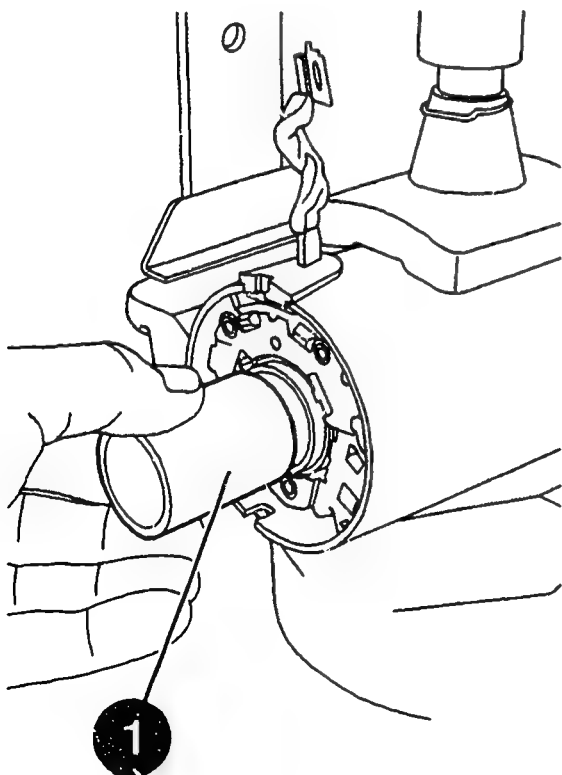
**ATTENTION:** Make sure thread of locating sleeve does not damage armature shaft.

Brush holder  
locating sleeve:

0 986 618 134

Continue: II03/1 Fig.: II02/2

KMS00402



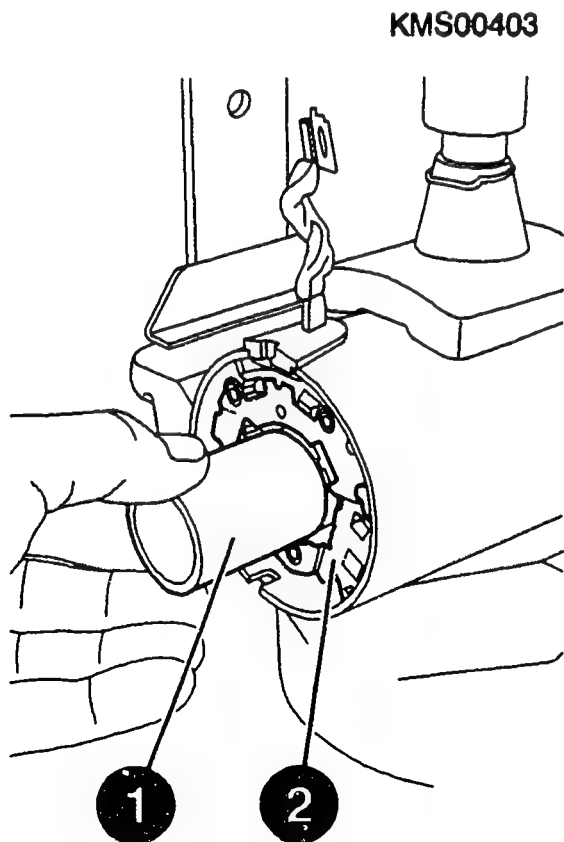
## STARTING MOTOR DISASSEMBLY

### Disassembling armature

Carefully pull armature against force of permanent magnet out of stator frame towards drive-end bearing side and in doing so insert locating sleeve (1) into brush holder (2).

The carbon brushes must rest on the tool.

Continue: I22/1 Fig.: I103/2



## STARTING MOTOR DISASSEMBLY

Disassembling planetary gear train and overrunning-clutch drive.

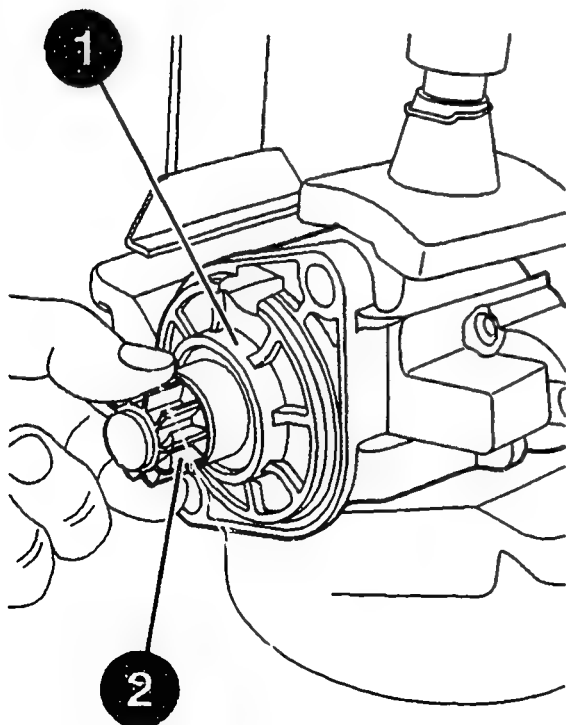
Remove drive-end bearing (1) from assembly stand and clamp it in clamping support.

Pull pinion (2) out of drive-end bearing as far as it will go.

Clamping support: 0 986 619 362

Continue: II05/1 Fig.: II04/2

KMS00404





## STARTING MOTOR DISASSEMBLY

Disassembling planetary gear train and  
overrunning-clutch drive

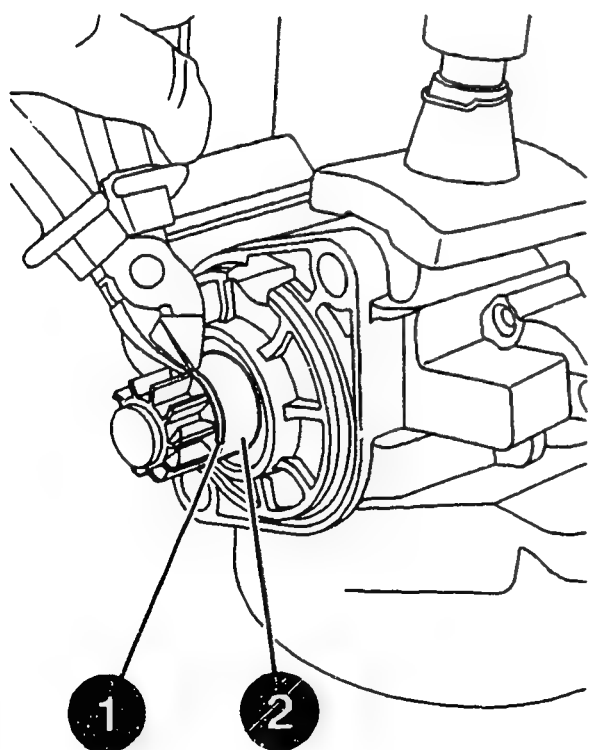
Use suitable tool (e.g. side-cutting  
pliers) to cut through thrust ring (1)  
and remove ring.

Take care not to damage bearing  
surface (2).

**DANGER OF INJURY**

Continue: II06/1 Fig.: II05/2

KMS00405



## STARTING MOTOR DISASSEMBLY

Disassembling planetary gear train and  
overrunning-clutch drive

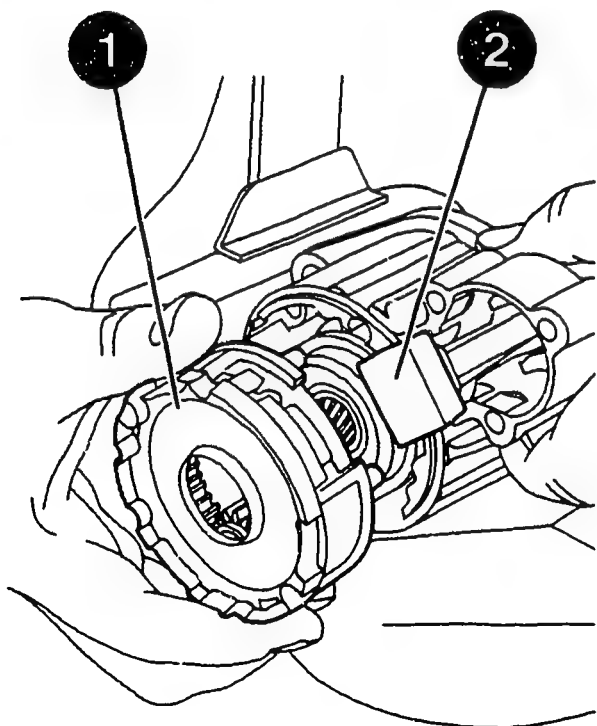
Pull planetary gear train (1) complete  
with overrunning-clutch drive, engaging  
lever and mount out of drive-end  
bearing.

Pay attention to rubber seal (2).  
Slip assembly horizontally onto  
assembly stand and position vertically  
to avoid damage.

Assembly stand for planetary gear train  
(reworked version): 0 986 617 138

Continue: I22/1 Fig.: II06/2

KMS00406



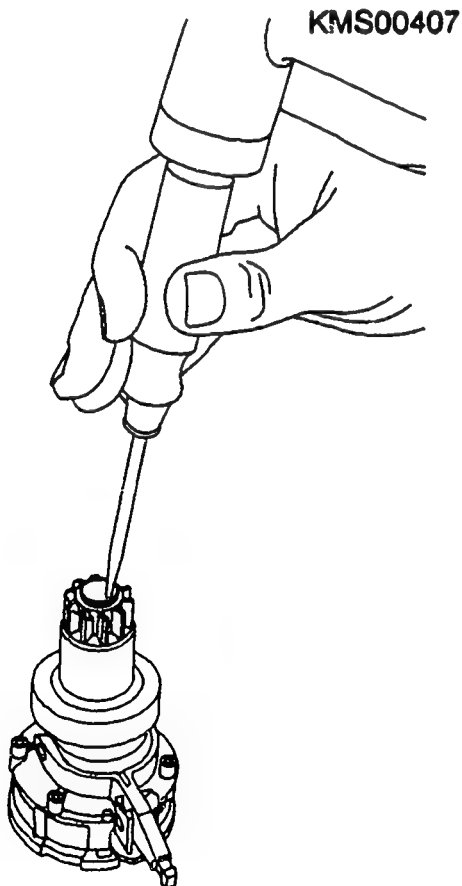
## STARTING MOTOR DISASSEMBLY

### Disassembling cap

Use plastic-headed hammer to gently tap suitable tool into the edge of the cap (see Fig.) and prise off cap.

**DANGER OF INJURY**

Continue: I22/1 Fig.: II07/2



## STARTING MOTOR DISASSEMBLY

### Disassembling overrunning-clutch drive

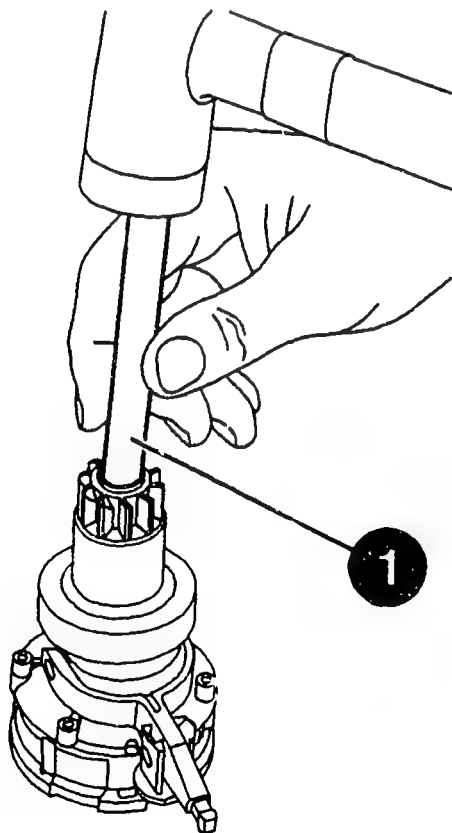
Slip disassembly sleeve (1) over output shaft and position on stop ring.

Knock back stop ring by tapping firmly (plastic-headed hammer) on disassembly sleeve.

Disassembly sleeve: 0 986 619 416

Continue: II09/1 Fig.: II08/2

KMS00408



## STARTING MOTOR DISASSEMBLY

Disassembling overrunning-clutch drive

Use suitable tool to remove snap ring (1) from output shaft.

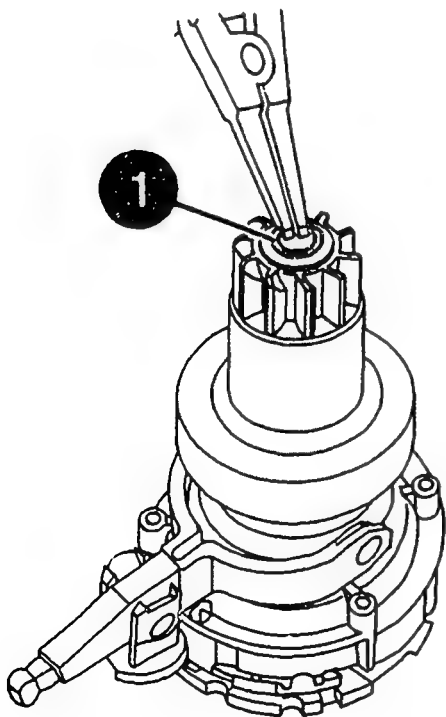
Take care not to damage output shaft.

### DANGER OF INJURY

The pretension may cause the snap ring to spring off the output shaft.

Continue: II10/1 Fig.: II09/2

KMS00409



## STARTING MOTOR DISASSEMBLY

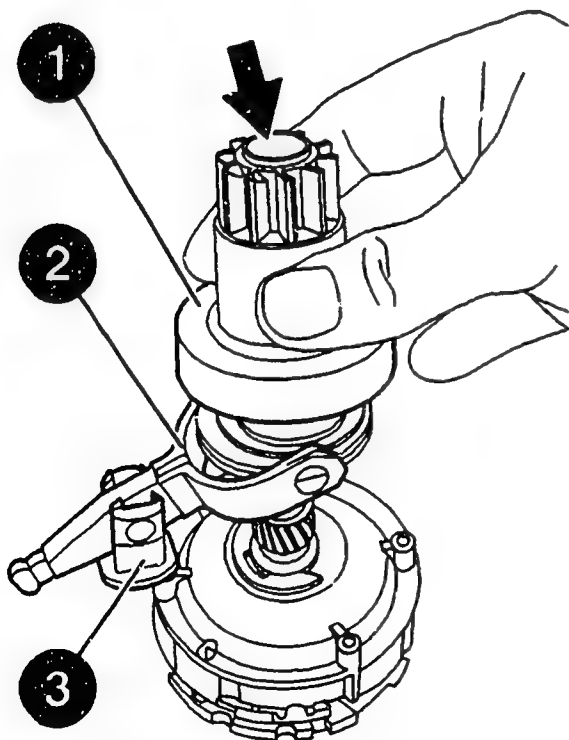
Disassembling overrunning-clutch drive

Remove overrunning-clutch drive (1) with engaging lever (2) and mount (3) from output shaft.

Pay attention to stop ring in pinion hole (see arrow).

Continue: I22/1 Fig.: II10/2

KMS00410



## **COMPONENT CLEANING**

### **Component cleaning:**

Armature, commutator end shield, solenoid switch and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other parts such as planetary gear train (not plastic components) and drive-end bearing can be washed out with commercially available cleaning agent which is not readily flammable. Take care not to inhale vapours. Components must be re-lubricated or re-greased in line with lubrication schedule.

**Continue: II11/2**

## **COMPONENT CLEANING**

**Danger of fire:** Take care to avoid naked flames and sparking.

### **ATTENTION:**

Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

**Continue: II12/1**

## COMPONENT CLEANING

Always heed the following safety regulations:

- \* German Order governing the use of flammable liquids (VbF).
  - \* Accident prevention regulations for electrical systems and equipment.
  - \* Safety regulations for the handling of chlorinated hydrocarbons:
    - For companies: ZH 1/222
    - For employees: ZH 1/129
- issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: II12/2

## COMPONENT CLEANING

Outside Germany, pay attention to appropriate local regulations.

Skin protection:

To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1



## TESTING, REPAIR TABLE

Checking pinion	II14/1
Checking drive-end bearing	II15/1
Checking commutator end shield	II21/1
Checking overrunning-clutch drive	II23/1
Checking planetary gear unit	II25/1
Checking armature	III03/1
Checking commutator	III06/1
Checking carbon-brush wear	III09/1
Checking stator frame	III13/1
Checking solenoid switch	III14/1

Continue: I01/1

## COMPONENT TESTING AND REPAIR

### Testing pinion

Meshing pinion and overrunning-clutch drive are subject to considerable wear. Overrunning-clutch drive is therefore always to be replaced.

Continue: II13/1

## COMPONENT TESTING AND REPAIR

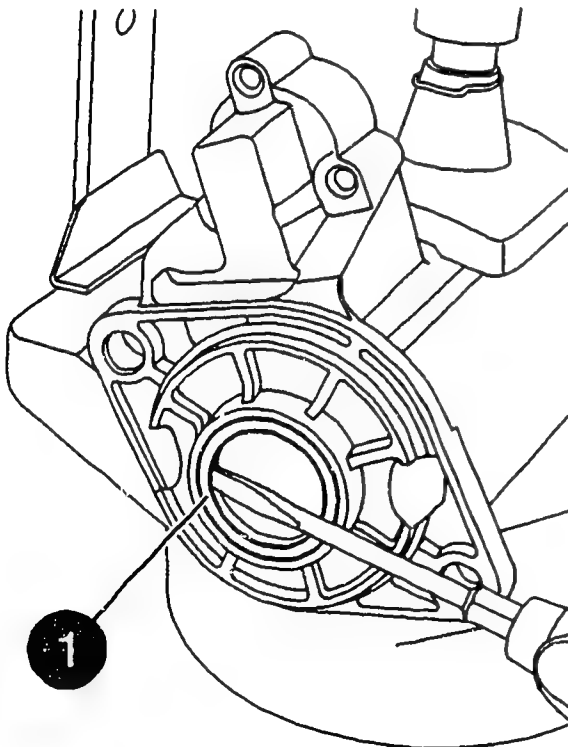
### Checking drive-end bearing

Sealing ring and bushing of drive-end bearing must always be replaced.

Sealing ring removal:  
Use suitable tool to prise out sealing ring (1).

Continue: II16/1 Fig.: II15/2

KMS00411



## COMPONENT TESTING AND REPAIR

### Checking drive-end bearing

#### Bushing removal:

Use pressing-out mandrel (1) to press out bushing inwards.

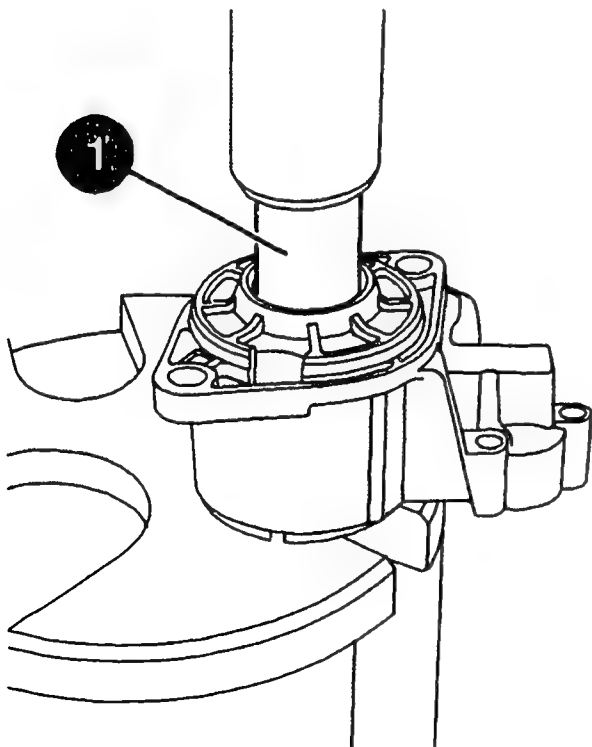
#### Mandrel press:

com. avail.

Pressing-out mandrel: to be improvised

Continue: II17/1 Fig.: II16/2

KMS00412



## COMPONENT TESTING AND REPAIR

### Checking drive-end bearing

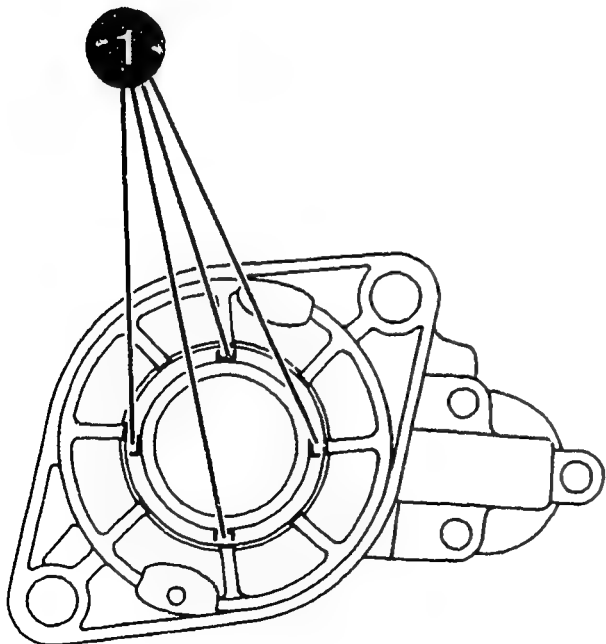
After removing sealing ring and bushing, use three-square scraper to carefully clean off projecting caulking (1) material.

**ATTENTION:** Take care not to damage fitting surfaces of bearing and sealing ring seat.

Three-square scraper: comm. avail.

Continue: II18/1 Fig.: II17/2

KMS00413



## COMPONENT TESTING AND REPAIR

### Checking drive-end bearing

#### Bushing installation:

Make direct use of mandrel of mandrel press to carefully press bushing from inside into drive-end bearing such that it is flush.

**ATTENTION:** Pockets of new bushing must be completely filled with grease.

Mandrel press:

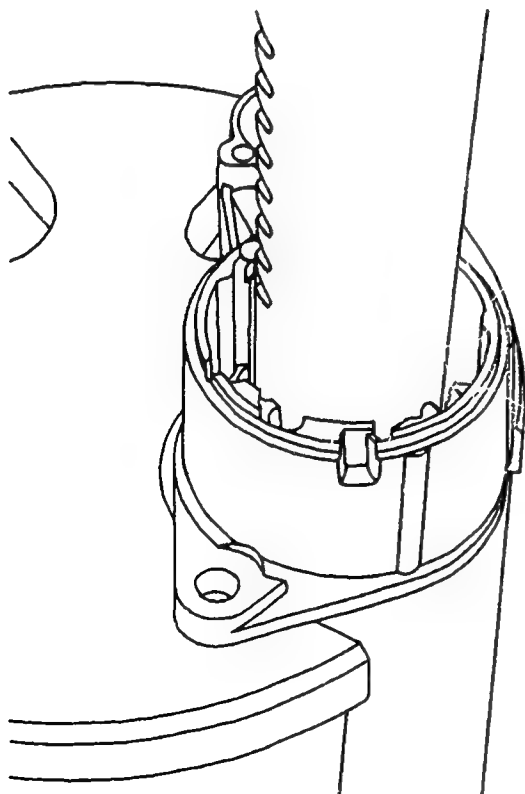
comm. avail.

Grease VS 18099 Ft:

5 997 287 000

Continue: II19/1 Fig.: II18/2

KMS00414



## COMPONENT TESTING AND REPAIR

Checking drive-end bearing

Sealing ring installation:

Fill seat of sealing ring in drive-end bearing with grease.

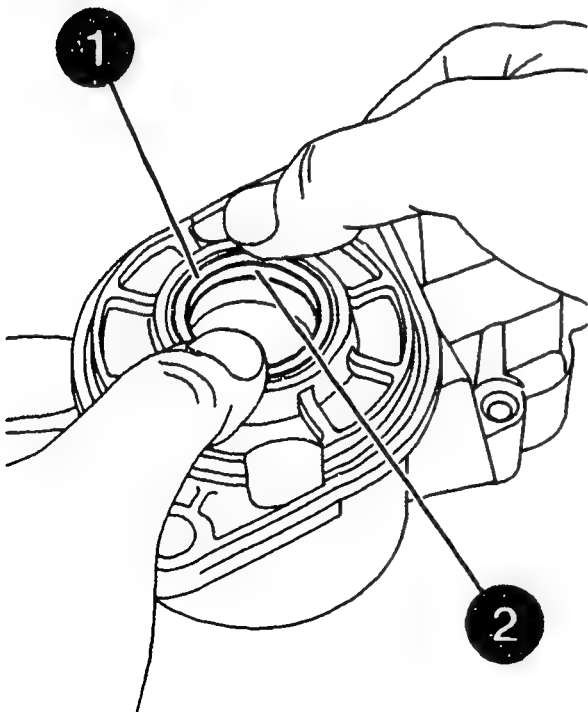
Press home sealing ring (1) by hand in drive-end bearing.

**ATTENTION:** Gap (2) between sealing ring and bushing must be completely filled with grease.

Grease VS 18099 Ft: 5 997 287 000

Continue: II20/1 Fig.: II19/2

KMS00415



## COMPONENT TESTING AND REPAIR

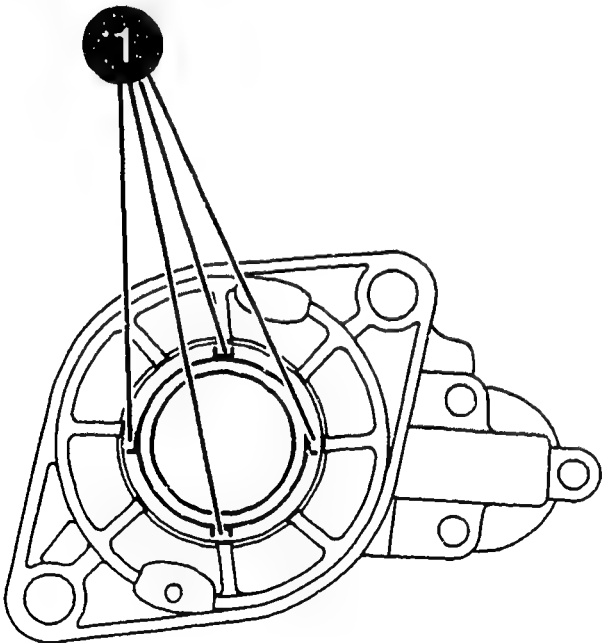
### Checking drive-end bearing

Sealing ring installation (continued):  
Use small cape chisel to caulk drive-end bearing at four locations (1) (mutually offset by 90) to ensure that sealing ring is firmly attached. Take care not to damage seat of sealing ring.  
Remove surplus grease after assembly.

Small cape chisel: comm. avail.

Continue: II13/1 Fig.: II20/2

KMS00416





## COMPONENT TESTING AND REPAIR

### Checking commutator end shield

Check bushing for damage and scoring.

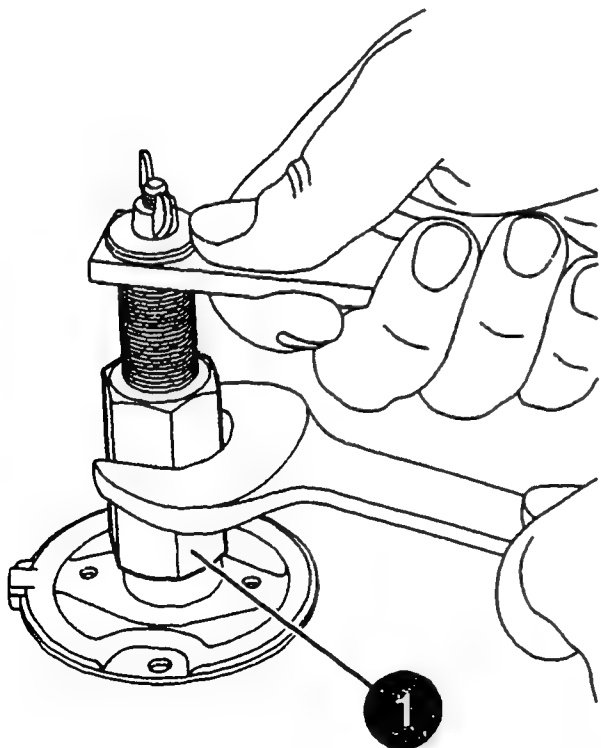
Replace if necessary.

Removal: Use puller (1) and spring collet to pull bushing out of commutator end shield.

Puller:	0 986 617 243
Spring collet diameter 10 mm:	0 986 617 250

Continue: II22/1 Fig.: II21/2

KMS00417



## COMPONENT TESTING AND REPAIR

### Checking commutator end shield

**Installation:** Use pressing-in mandrel (2) to press new bushing (1) from inside (see Fig.) into commutator end shield such that it ends 0.2...0.4 mm before outer collar of commutator end shield.

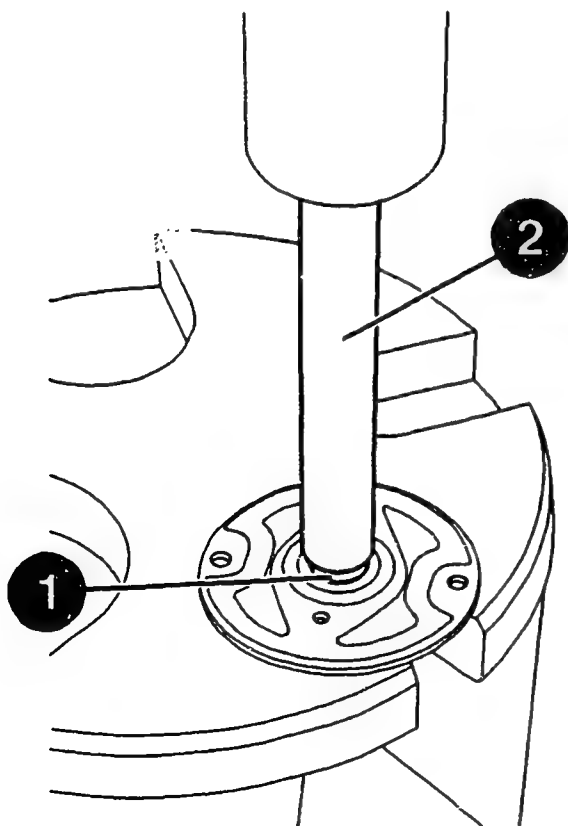
If necessary, press in to required dimension using old bushing.

**ATTENTION:** New bushing must be moistened beforehand with suitable oil.

Mandrel press:	comm. avail.
Pressing-in mandrel:	0 986 617 149
Oil VS 13 834-01:	5 962 260 000

Continue: II13/1 Fig.: II22/2

KMS00418



## COMPONENT TESTING AND REPAIR

### Checking overrunning-clutch drive

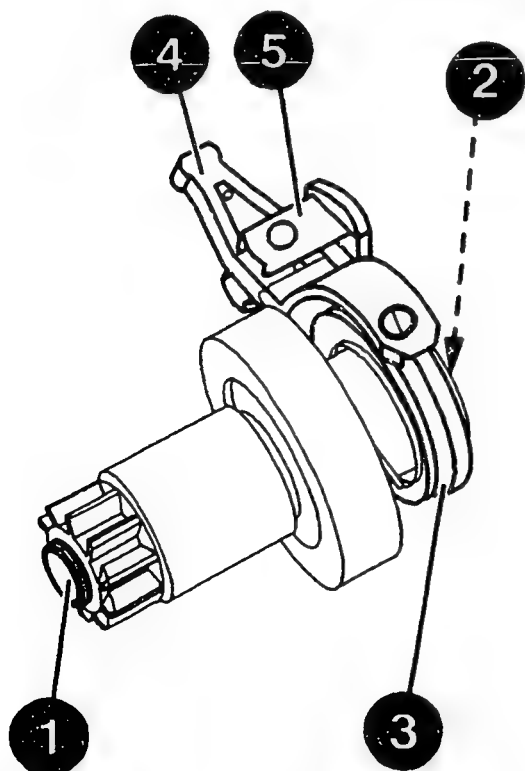
Pinion, bushings (1), spiral spline (2) and driver edges (3) of overrunning-clutch drive are subject to a high degree of wear.

The overrunning-clutch drive is thus always to be replaced.

Also replace engaging lever (4) and its mount (5).

Continue: II24/1 Fig.: II23/2

KMS00482



## COMPONENT TESTING AND REPAIR

### Checking overrunning-clutch drive

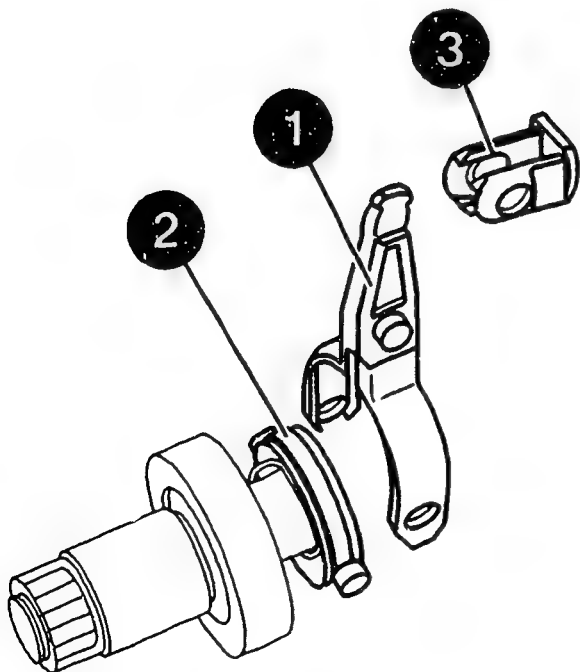
Engage new engaging lever (1) at driver (2) on overrunning-clutch drive.

Engage new mount (3) at engaging lever with open end facing pinion.

**NOTE:** Fig. shows disassembled engaging lever and mount.

Continue: II13/1 Fig.: II24/2

KMS00481



## COMPONENT TESTING AND REPAIR

### Checking planetary gear train

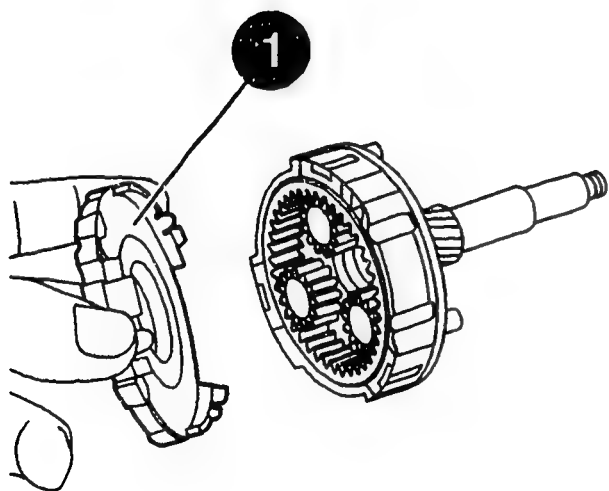
#### Disassembly:

Remove assembly from assembly stand.

Remove cover (1).

Continue: II26/1 Fig.: II25/2

KMS00419



## COMPONENT TESTING AND REPAIR

### Checking planetary gear train

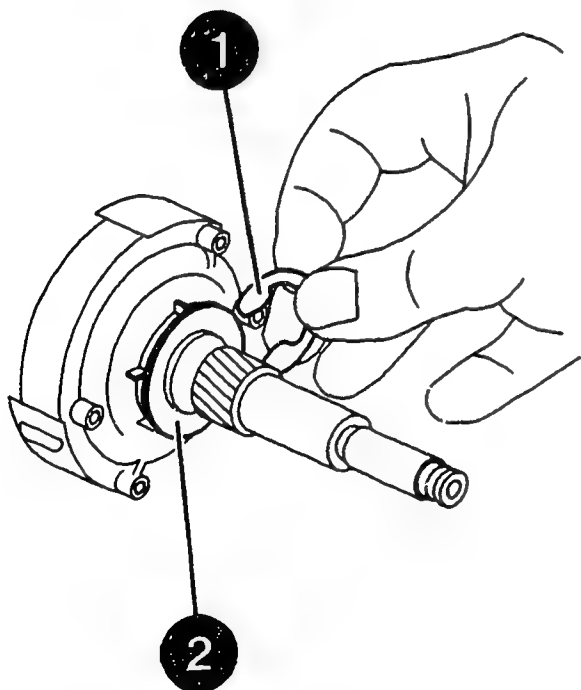
#### Disassembly (continued):

Remove circlip (1) and detach washer (2).

Pull output shaft out of gear shell.

Continue: II27/1 Fig.: II26/2

KMS00480



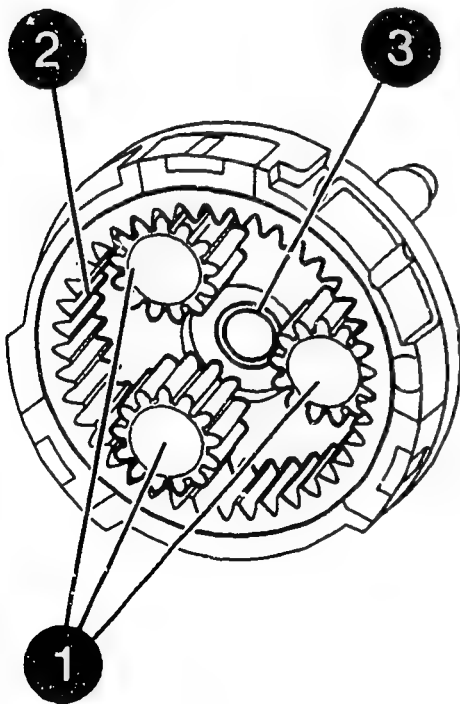
## COMPONENT TESTING AND REPAIR

### Checking planetary gear train

The complete planetary gear train must be replaced if the planet gears (1), the internal geared wheel (2) or the sun gear bushing (3) are/is worn.

Continue: II28/1 Fig.: II27/2

KMS00420



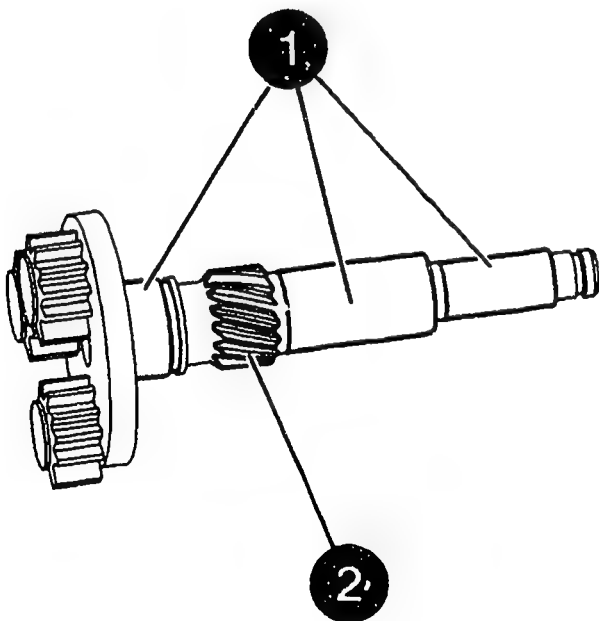
## COMPONENT TESTING AND REPAIR

### Checking planetary gear train

The complete planetary gear train must also be replaced if one of the bearing surfaces (1) on the output shaft or the spiral spline (2) is worn or damaged.

Continue: IIII01/1 Fig.: II28/2

KMS00421





## COMPONENT TESTING AND REPAIR

### Checking planetary gear train

#### Assembly:

Lubricate in line with lubrication schedule during assembly.

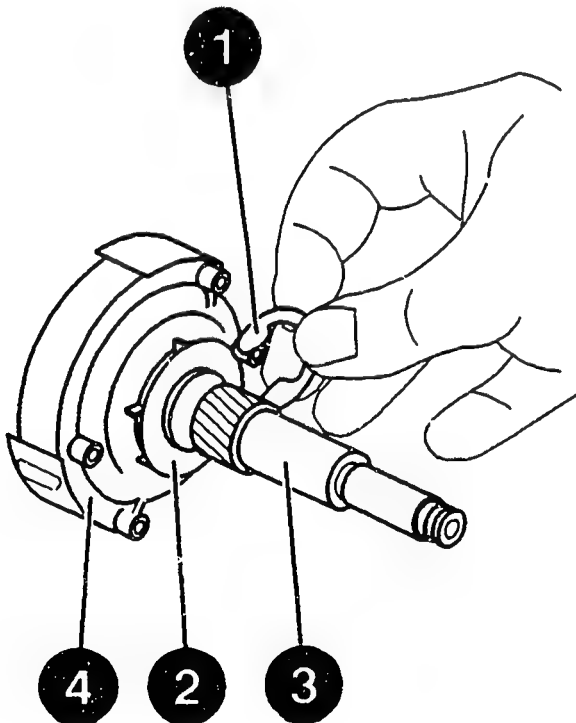
Insert output shaft (3) in gear shell (4).

Slip washer (2) onto output shaft. Secure circlip (1).

Grease VS 16069-FT: 5 984 610 120

Continue: III02/1 Fig.: III01/2

KMS00483



## COMPONENT TESTING AND REPAIR

### Checking planetary gear train

#### Assembly (continued):

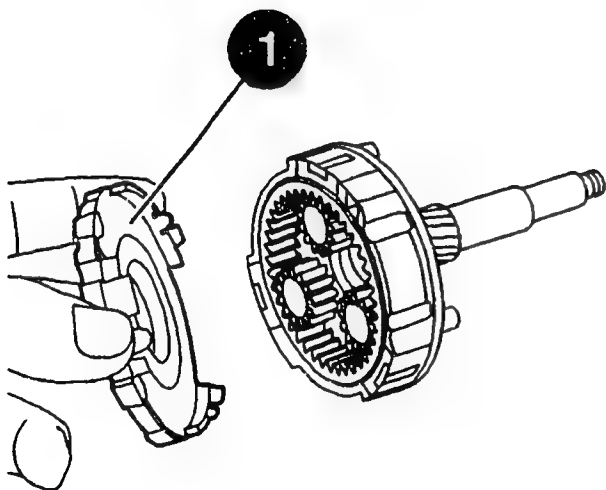
Fit cover (1). Pay attention to correct position of holes for bolts.

Slip planetary gear train onto assembly stand and position it vertically.

Assembly stand for planetary gear train  
(reworked version): 0 986 617 138

Continue: III13/1 Fig.: III02/2

KMS00419



## COMPONENT TESTING AND REPAIR

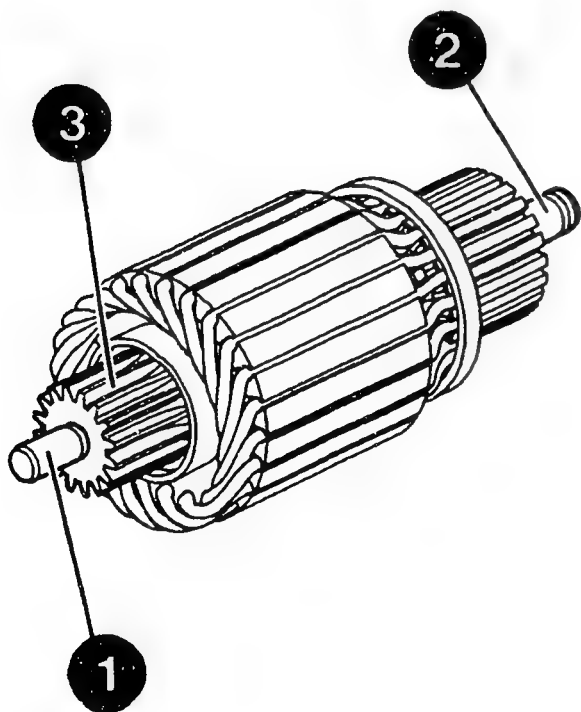
### Checking armature

Examine bearing surface of sun gear bushing (1) and commutator end shield (2), as well as sun gear (3) for scoring and damage.

Replace armature if necessary.

Continue: III04/1 Fig.: III03/2

KMS00319



## COMPONENT TESTING AND REPAIR

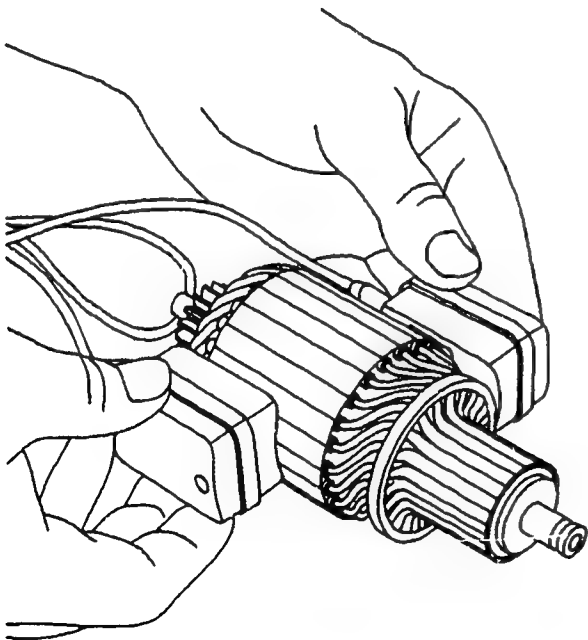
### Testing armature

Check armature for interturn short circuit using tester and test probes.

Interturn short-circuit  
tester with test probes: 0 986 619 110

Continue: III05/1 Fig.: III04/2

KMS00320



# COMPONENT TESTING AND REPAIR

## Checking armature

Use tester and test prods to check armature for short to ground and continuity (black laminations are an indication of open circuit).

Interturn-short-circuit  
tester:

0 986 619 110

Test prods:

0 986 619 101

Test voltage for  
checking short to ground:

40 V\*

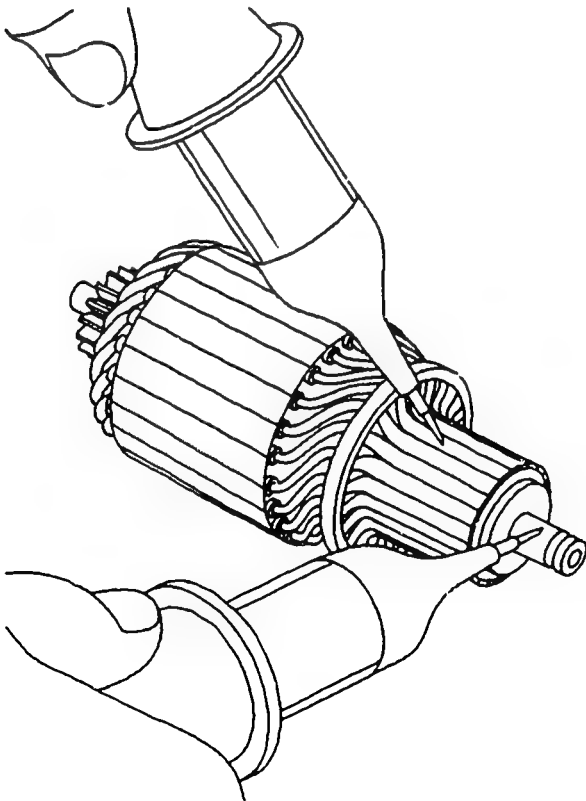
Continuity test voltage:

40 V\*

\* = AC

Continue: II13/1 Fig.: III05/2

KMS00321



# COMPONENT TESTING AND REPAIR

## Testing commutator

Check commutator concentricity.  
If radial run-out is outside stated  
range, commutator must be turned  
down.

Magnetic measurement  
stand:

4 851 601 124

Dial indicator:

1 687 233 011

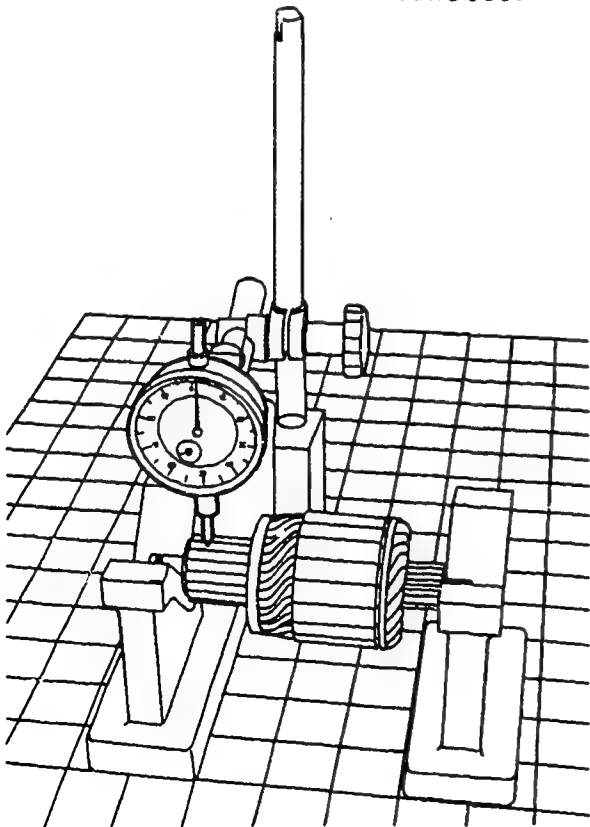
Radial run-out

- Commutator:

< 0,01 mm

Continue: III07/1 Fig.: III06/2

KMS00322



# COMPONENT TESTING AND REPAIR

## Testing commutator

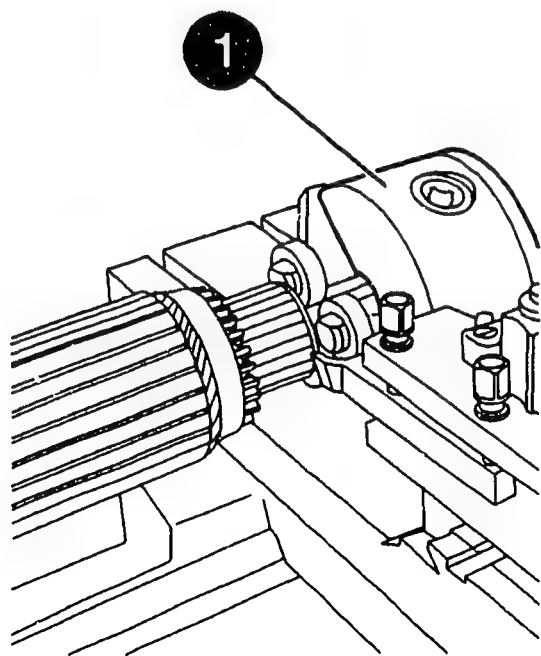
Turning down involves positioning armature in three-jaw chuck and tailstock rest (1). The max. machining thickness is 0.03 mm. Pay attention to minimum diameter.

Tailstock rest with Morse taper 2: 0 986 619 156

Minimum diameter: 31,2 mm

Continue: III08/1 Fig.: III07/2

KMS00193



## COMPONENT TESTING AND REPAIR

### Checking commutator

After turning down, the commutator segment insulation must be sawn out to a depth of 0.8 mm with a suitable tool.

After sawing out, turn down commutator again and check armature for interturn short circuit and short to ground. Pay attention to diameter.

The carbon-brush wear dimension is also to be checked with turned-down armature.

Continue: III08/2

## COMPONENT TESTING AND REPAIR

The brush holder is to be replaced if necessary.

Interturn-short-circuit  
tester: 0 986 619 110

Minimum diameter: 31,2 mm

Test voltage when checking  
for short to ground: 40 V\*

\* = AC

Continue: II13/1



## COMPONENT TESTING AND REPAIR

### Checking carbon brush wear

The wear dimension must be checked with the armature fitted.

Clamp armature in clamping support.

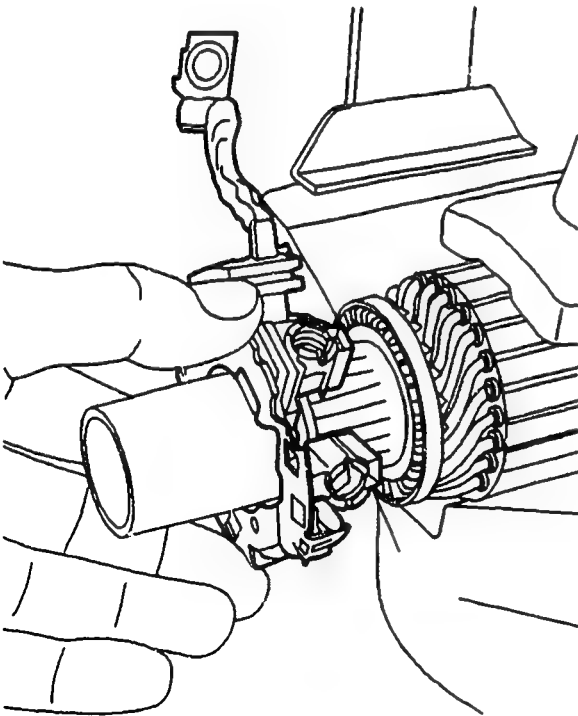
Pull brush holder with locating sleeve out of stator frame and slip onto armature shaft.

Slip brush holder from locating sleeve onto commutator.

Clamping support: 0 986 619 362

Continue: III10/1 Fig.: III09/2

KMS00423



# COMPONENT TESTING AND REPAIR

## Checking carbon brush wear

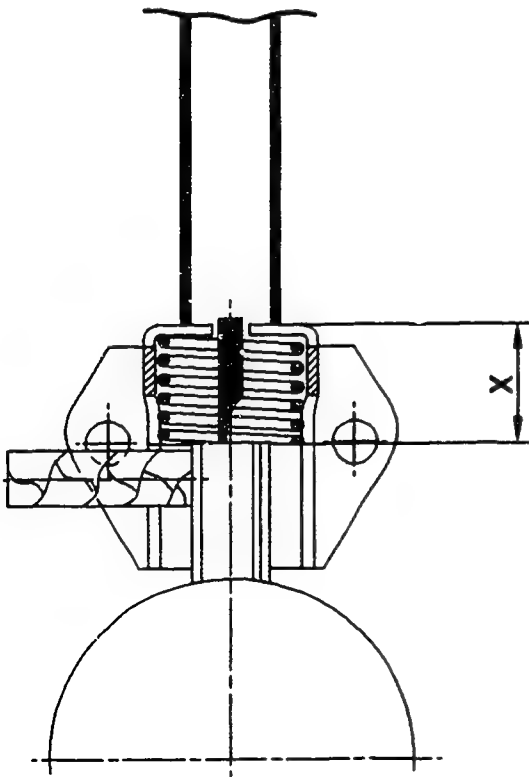
The carbon-brush wear dimension  $x$  is measured with a depth gauge from the top edge of the cartridge-type brush holder to the top edge of the carbon brush.

Carbon-brush  
wear dimension  $x$ :

< 14 mm

Continue: III11/1 Fig.: III10/2

KMS00393



## COMPONENT TESTING AND REPAIR

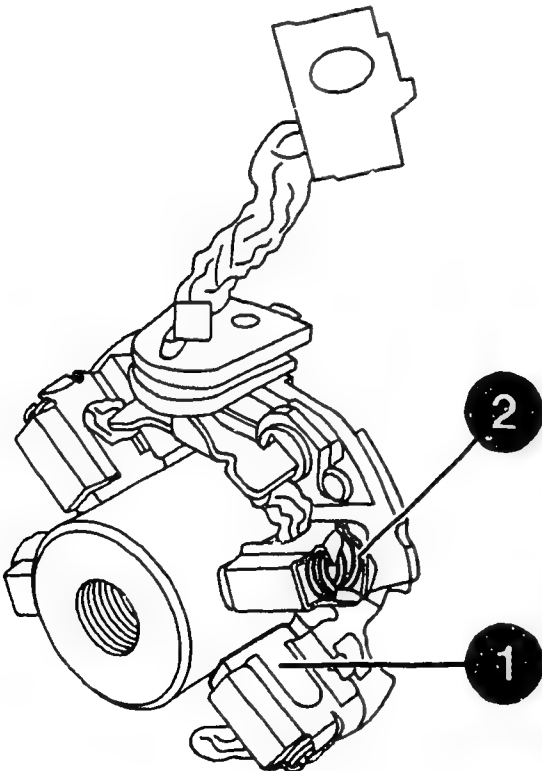
### Checking carbon brush wear

The entire brush holder must be replaced if the carbon brushes (1) are worn down to the minimum length or damaged or if the helical compression springs (2) are worn.

Exclusive use is to be made of replacement parts from the list applying to the type of starting motor concerned.

Continue: III12/1 Fig.: III11/2

KMS00424



## COMPONENT TESTING AND REPAIR

### Checking carbon brush wear

#### Brush holder installation:

Fit new brush holder in stator frame.

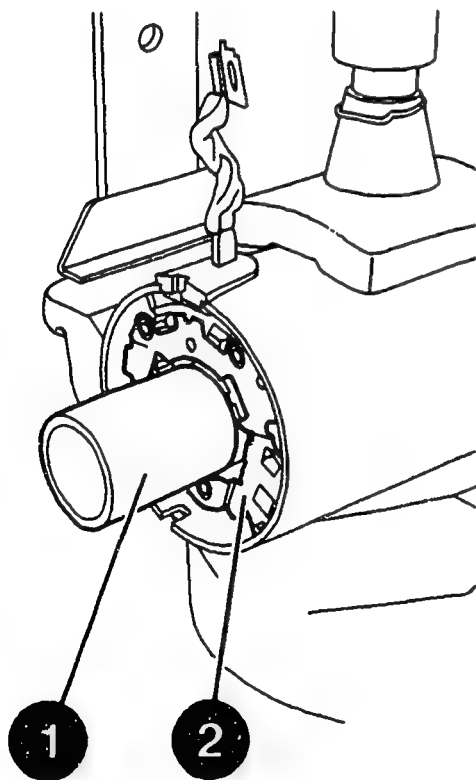
If old brush holder is re-used, slip it back onto locating sleeve (1) from commutator and insert in stator frame. Ensure correct positioning of locking element (2).

Brush holder  
locating sleeve:

0 986 618 134

Continue: III13/1 Fig.: III12/2

KMS00425



## **COMPONENT TESTING AND REPAIR**

### **Checking stator frame**

**Check stator frame for damage.**

**Check permanent magnets for generating exciter field for damage and correct positioning in stator frame.**

**If necessary, the entire stator frame is to be replaced.**

**Continue: II13/1**

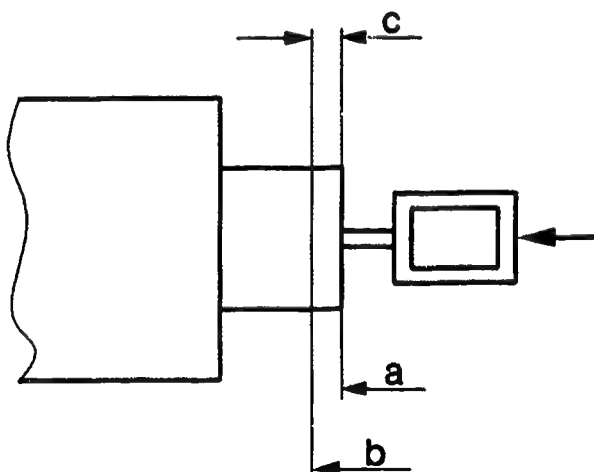
## COMPONENT TESTING AND REPAIR

### Testing solenoid switch

Examine solenoid switch for damage. Check burn-off reserve. Press in armature by hand until current bridge is resting (a) on terminal stud. On pressing in the armature further as far as stop (b) a noticeable increase in force is apparent. The difference between positions (a) and (b) is the burn-off reserve (c). If there is no further burn-off reserve, the solenoid switch must be replaced.

Continue: III15/1 Fig.: III14/2

KMS00375



# COMPONENT TESTING AND REPAIR

## Checking solenoid switch

Use tester to check resistance of pull-in winding (term. 50/term. 45).

Alternator tester: 0 684 201 200

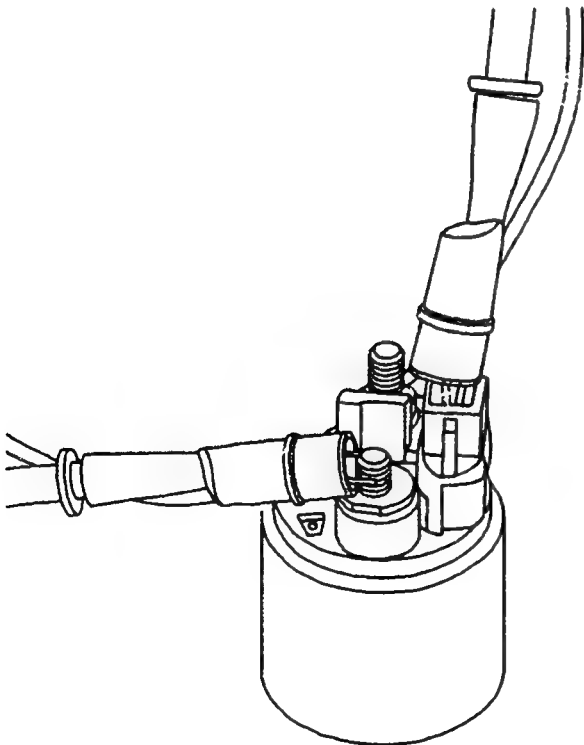
### Starting-motor resistance

0 001 121 002: 0,3...0,4 Ohm

0 001 121 0...: 0,3...0,4 Ohm

Continue: III16/1 Fig.: III15/2

KMS00426



# COMPONENT TESTING AND REPAIR

## Checking solenoid switch

Use tester to check resistance of holding winding (term. 50/ground).

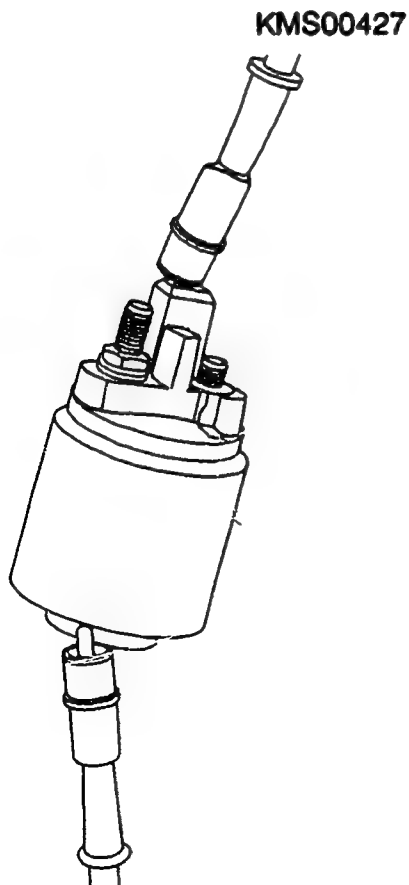
Alternator tester: 0 684 201 200

### Starting-motor resistance

0 001 121 002: 1,5...1,9 Ohm

0 001 121 0...: 1,5...1,7 Ohm

Continue: III17/1 Fig.: III16/2





## COMPONENT TESTING AND REPAIR

### Testing solenoid switch

Neither the tests described, nor proper functioning of the solenoid switch when testing the function of the starting motor following repairs can provide reliable information on long-term trouble-free operation of the solenoid switch.

It is therefore advisable to renew the solenoid switch when the starting motor is repaired.

Continue: II13/1

## STARTING MOTOR ASSEMBLY TABLE

Overrunning-clutch drive assembly	III19/1
Cap assembly	III25/1
Overrunning-clutch drive and planetary gear train assembly	III28/1
Thrust ring assembly (pinion with 9 teeth)	IV02/1
Thrust ring assembly (pinion with 10 teeth)	IV05/1
Armature assembly	IV10/1
Drive-end bearing assembly	IV12/1
Commutator end shield assy.	IV13/1
Checking and adjusting armature axial clearance	IV15/1

Continue: III18/2

## STARTING MOTOR ASSEMBLY TABLE

Bearing end plate assembly	IV17/1
Checking armature braking torque	IV18/1
Checking clutch overrunning torque	IV21/1
Checking total pinion travel	IV23/1
Solenoid switch assembly	IV24/1
Painting starting motor	IV27/1

Continue: I01/1

## **STARTING MOTOR ASSEMBLY**

### **Assembling overrunning-clutch drive**

**Lubricate in line with lubrication schedule before and during starting-motor assembly.**

**During assembly of overrunning-clutch drive, cover of planetary gear train is to be secured to stop it falling.**

**Continue: III20/1**

## STARTING MOTOR ASSEMBLY

### Assembling overrunning-clutch drive

Slip overrunning-clutch drive (1) with engaging lever (2) and mount (3), as well as new stop ring (4) onto output shaft.

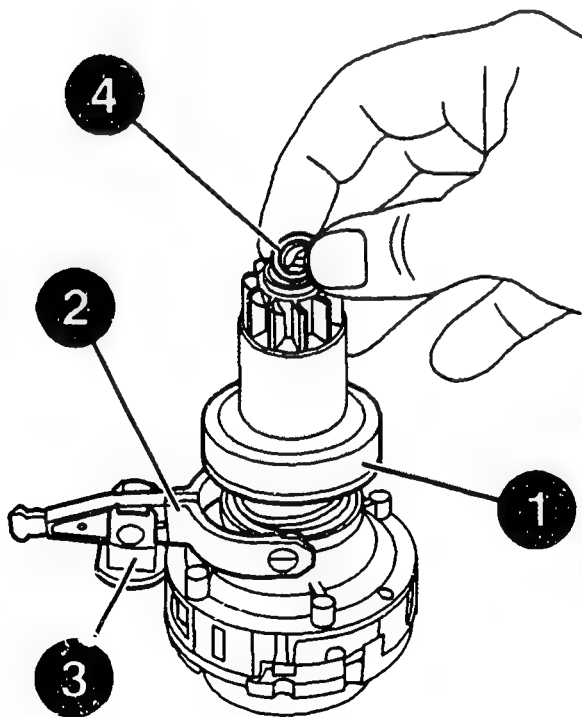
**ATTENTION:** Spiral spline of drive must be dry and free from grease to stop the output shaft becoming pasty. Only grease spiral spline on output shaft.

Grease VS 18036 Ft:

5 997 098 000

Continue: III21/1 Fig.: III20/2

KMS00428



## STARTING MOTOR ASSEMBLY

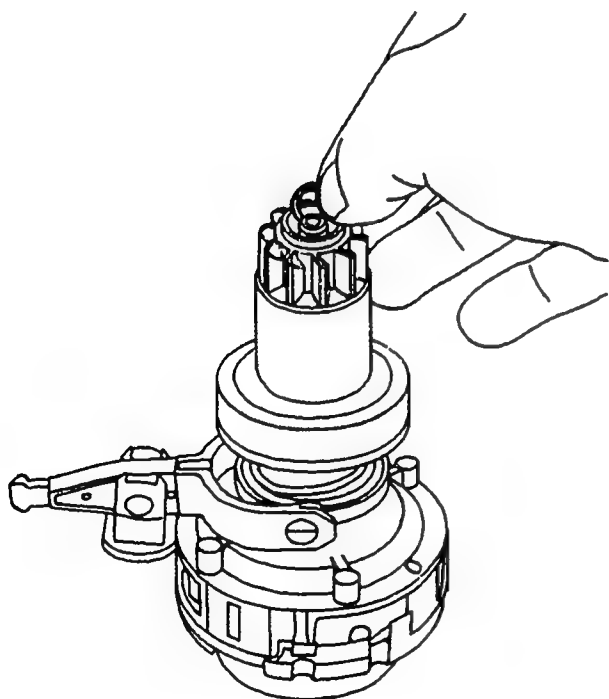
Assembling overrunning-clutch drive

Insert new snap ring in annular groove.

**ATTENTION:** Take care not to damage output shaft.

Continue: III22/1 Fig.: III21/2

KMS00429



## STARTING MOTOR ASSEMBLY

### Assembling overrunning-clutch drive

Attach holding fixture (1) to pinion body (2) such that it rests on overrunning clutch (3).

Use torque wrench.

**ATTENTION:** Take care not to damage surface of body.

Holding fixture:

0 986 619 420

Torque wrench:

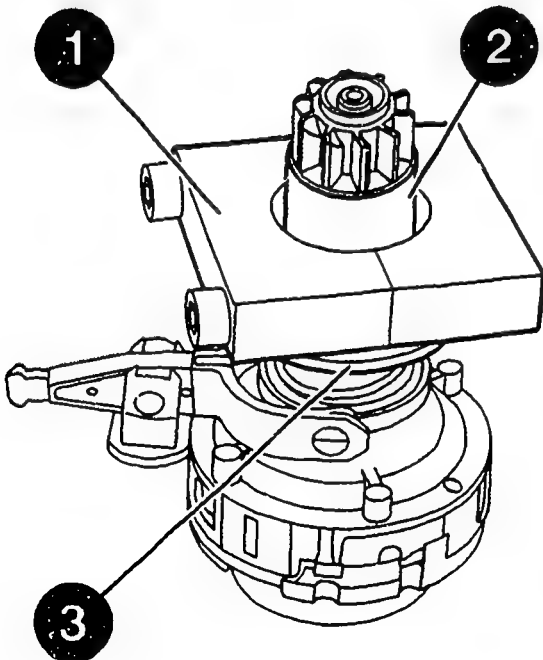
comm. avail.

Tightening torque:

25 Nm

Continue: III23/1 Fig.: III22/2

KMS00430



## STARTING MOTOR ASSEMBLY

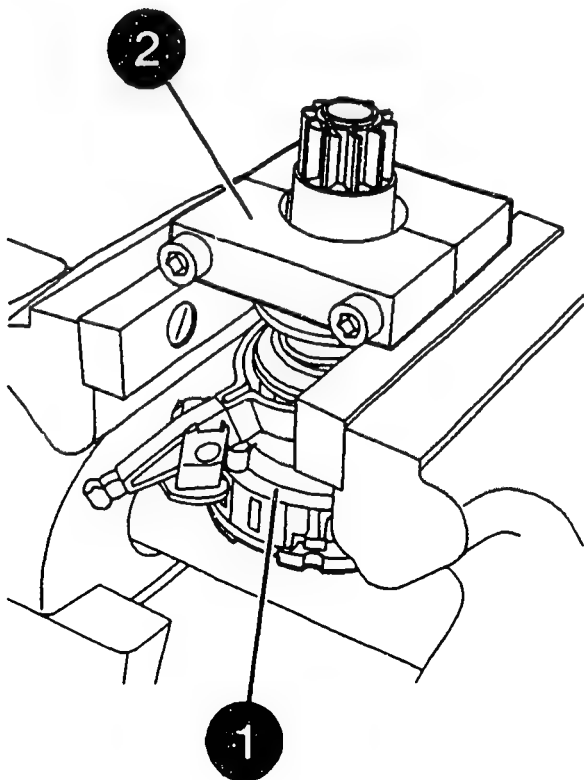
### Assembling overrunning-clutch drive

Remove planetary gear train (1) assembly from assembly stand and position with holding fixture (2) on vice.

**ATTENTION:** Assembly must not make contact with vice and must be freely accessible from underneath.

Continue: III24/1 Fig.: III23/2

KMS00431



## STARTING MOTOR ASSEMBLY

### Assembling overrunning-clutch drive

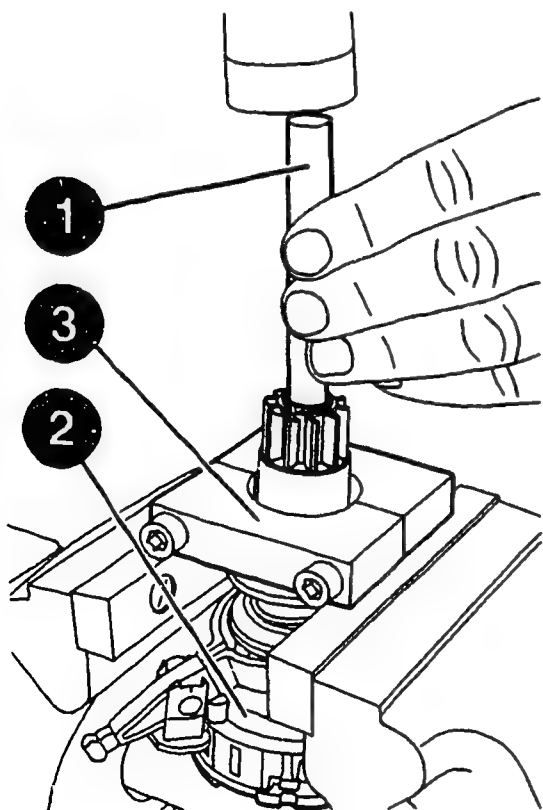
Mount tapered end of assembly sleeve (1) on output shaft.

Tapping firmly (plastic-headed hammer) on assembly sleeve engages snap ring beneath stop ring. Remove assembly sleeve, position assembly (2) on assembly stand, remove holding fixture (3).

Assembly sleeve:	0 986 619 415
Assembly stand for planetary gear train (reworked version):	0 986 617 138

Continue: III18/1 Fig.: III24/2

KMS00432





## **STARTING MOTOR ASSEMBLY**

**Assembling cap**

### **NOTE ON PRESSING ON CAP:**

**Slowly increase pressure whilst pressing on cap and check firmness of cap several times.**

**Only exert sufficient pressure to ensure firm fit of cap.**

**Excessive pressure could destroy components.**

**Continue: III26/1**

## STARTING MOTOR ASSEMBLY

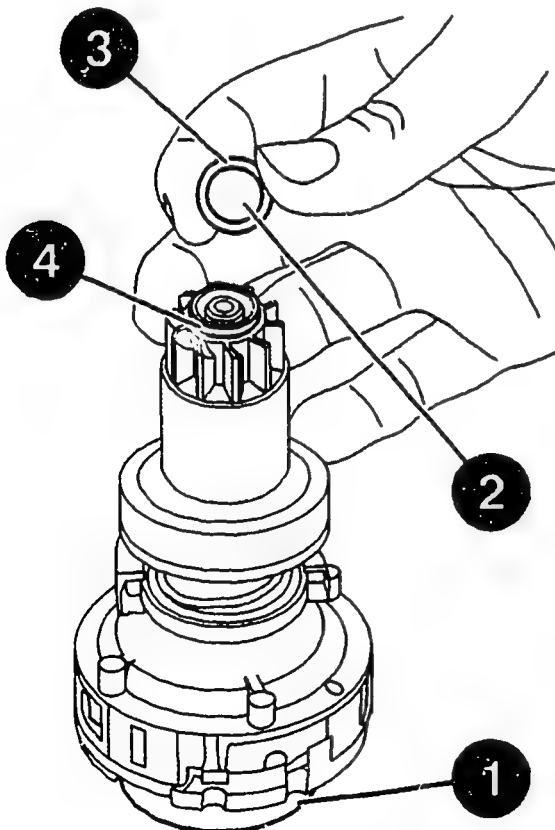
### Assembling cap

Leave assembly on assembly stand (1) whilst assembling cap.

Position cap (2) with inserted sealing ring (3) on pinion collar (4).

Continue: III27/1 Fig.: III26/2

KMS00433



## STARTING MOTOR ASSEMBLY

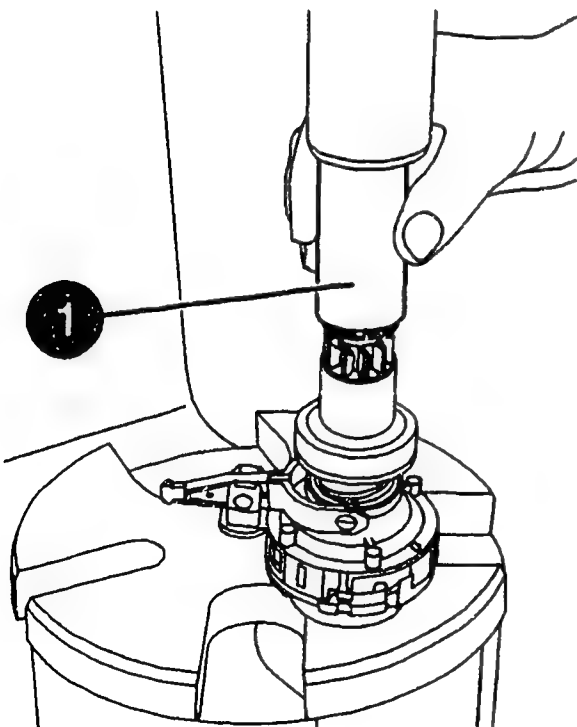
### Assembling cap

**ATTENTION:** Always heed pressing-on instructions.  
Fit collet chuck (1) and carefully press on cap using mandrel press. Check firmness of cap several times. Make sure collet chuck is correctly positioned. Release press, turn collet chuck through 45 and press on again. Remove collet chuck and check correct positioning of cap.

Mandrel press: comm. avail.  
Collet chuck: 0 986 619 408/412

Continue: III18/1 Fig.: III27/2

KMS00434



## STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive  
and planetary gear train

Use three-square scraper to clean  
fitting surfaces at drive-end bearing.

Three-square scraper:                comm. avail.

Continue: IV01/1

## STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive  
and planetary gear train

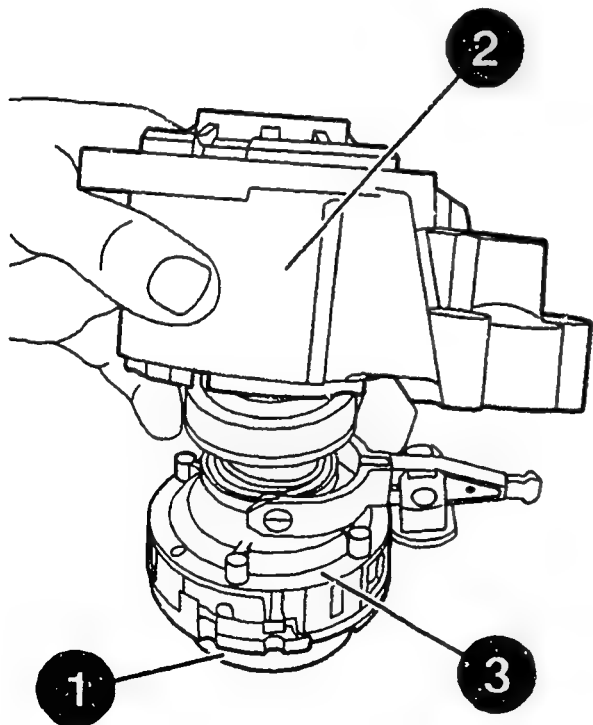
Leave assembly on assembly stand  
(1) during assembly.

Slip drive-end bearing (2) onto  
planetary gear train (3) assembly.

Pay attention to correct positioning  
of planetary gear train (rubber seal  
recess) and mount of engaging lever  
in drive-end bearing.

Continue: IIII18/1 Fig.: IV01/2

KMS00435



## STARTING MOTOR ASSEMBLY

Assembling thrust ring  
(pinion with 9 teeth)

### NOTE ON PRESSING ON THRUST RING:

Slowly increase pressure whilst  
pressing on and check firmness  
of thrust ring several times.

Only exert sufficient pressure to  
ensure firm fit of thrust ring.

Excessive pressure could destroy  
components.

Continue: IV03/1

## STARTING MOTOR ASSEMBLY

Assembling thrust ring  
(pinion with 9 teeth)

Leave assembly on assembly stand during assembly. Slip thrust ring (1) with contact surface facing drive-end bearing over pinion as far as collar.

### DANGER OF INJURY

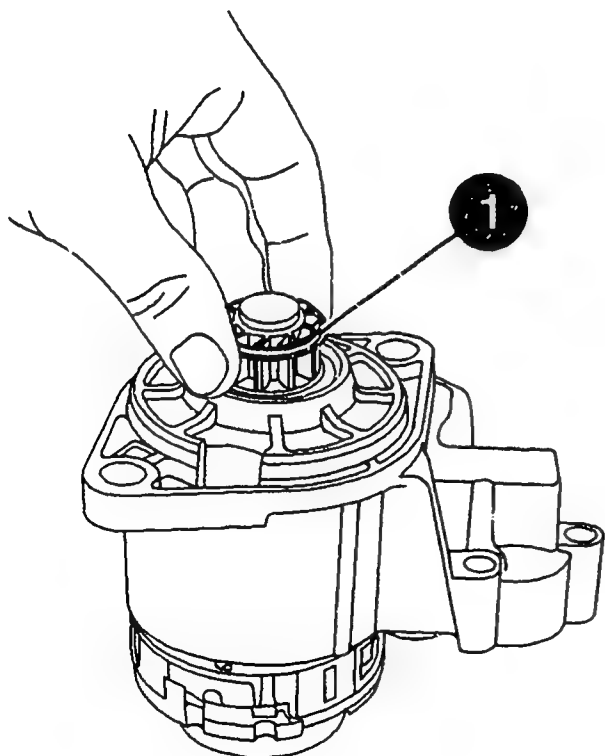
The thrust ring has sharp edges. Use pressing-on tool if necessary.

Pressing-on tool for  
pinion with 9 teeth:

0 986 619 404

Continue: IV04/1 Fig.: IV03/2

KMS00436



## STARTING MOTOR ASSEMBLY

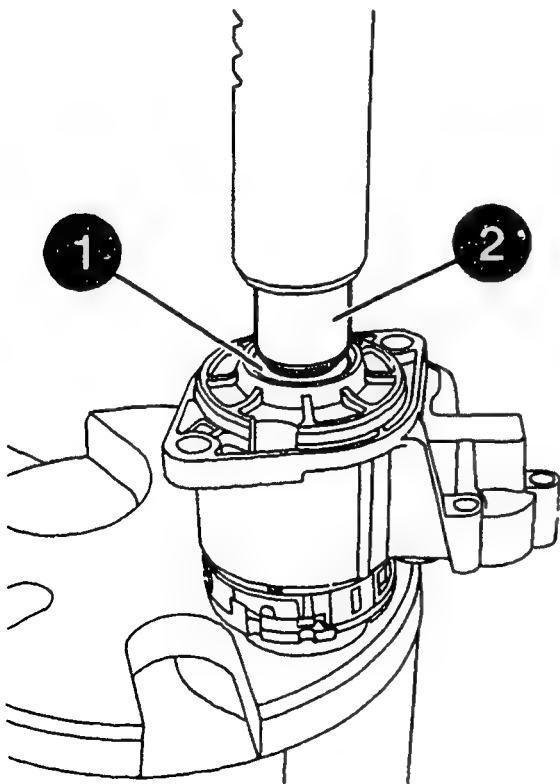
Assembling thrust ring  
(pinion with 9 teeth)

**ATTENTION:** Always pay attention to pressing-on instructions. Use pressing-on tool (2) and mandrel press (1) to carefully press on thrust ring (1). Check firmness of thrust ring several times. Remove pressing-on tool and check correct position of thrust ring again.

Mandrel press:	comm. avail.
Pressing-on tool for pinion with 9 teeth:	0 986 619 404

Continue: III18/1 Fig.: IV04/2

KMS00438





## **STARTING MOTOR ASSEMBLY**

**Assembling thrust ring  
(pinion with 10 teeth)**

### **NOTE ON PRESSING ON THRUST RING:**

**Slowly increase pressure whilst  
pressing on and check firmness  
of thrust ring several times.**

**Only exert sufficient pressure to  
ensure firm fit of thrust ring.**

**Excessive pressure could destroy  
components.**

**Continue: IV05/2**

## **STARTING MOTOR ASSEMBLY**

**Assembling thrust ring  
(pinion with 10 teeth)**

### **NOTE:**

**The body of the pinion must be  
absolutely clean, dry and free from  
grease to ensure firm attachment of  
the holding fixture.**

**Continue: IV06/1**

## STARTING MOTOR ASSEMBLY

Assembling thrust ring  
(pinion with 10 teeth)

Pull pinion out of drive-end bearing  
and attach (see Fig.) holding fixture  
(1) to pinion body (2).

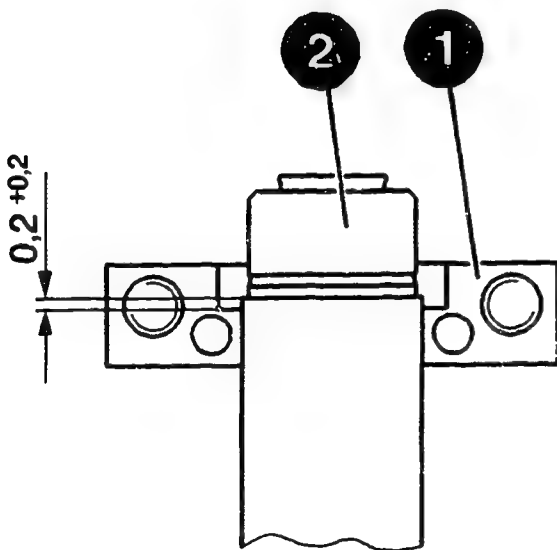
**ATTENTION:** Always adhere to stated  
dimension. Take care not to damage  
pinion body. Use torque wrench.

Holding fixture: 0 986 619 420  
Torque wrench: comm. avail.

Tightening torque: 25 Nm

Continue: IV07/1 Fig.: IV06/2

KMS00439



## STARTING MOTOR ASSEMBLY

Assembling thrust ring  
(pinion with 10 teeth)

Slip thrust ring (1) with contact surface facing holding fixture (2) over pinion until thrust ring rests on collar of pinion body.

### DANGER OF INJURY

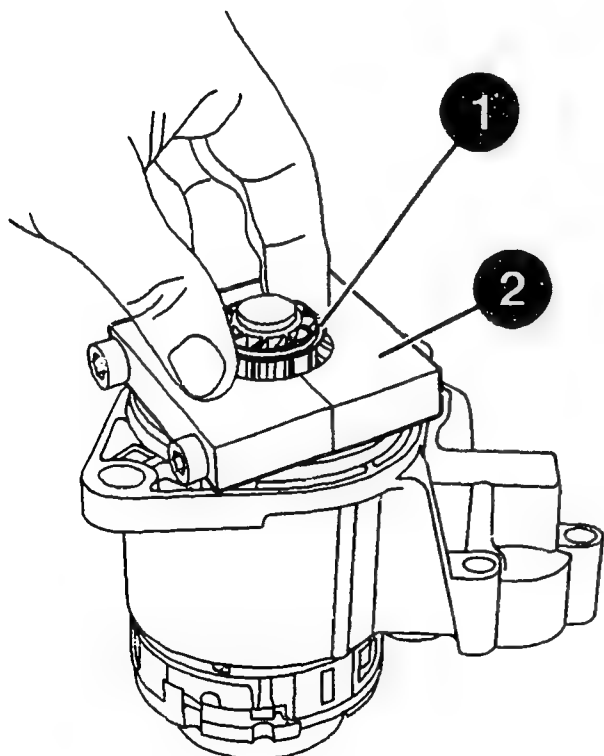
The thrust ring has sharp edges.  
Use pressing-on tool if necessary.

Pressing-on tool for  
pinion with 10 teeth:

0 986 619 405

Continue: IV08/1 Fig.: IV07/2

KMS0C440



## STARTING MOTOR ASSEMBLY

Assembling thrust ring  
(pinion with 10 teeth)

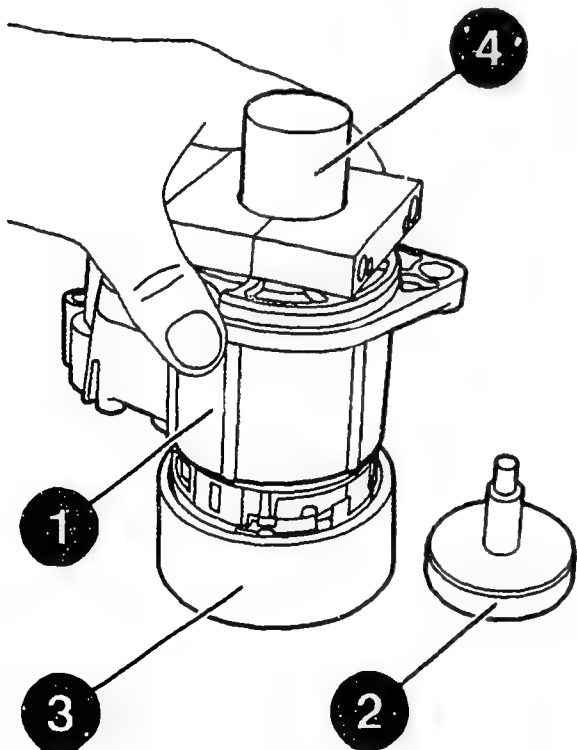
Remove assembly (1) from assembly  
stand (2) and position on support  
ring (3).

Slip pressing-on tool (4) onto pinion.

Support ring:	to be improvised
Pressing-on tool for pinion with 10 teeth:	0 986 619 405

Continue: IV09/1 Fig.: IV08/2

KMS00441



## STARTING MOTOR ASSEMBLY

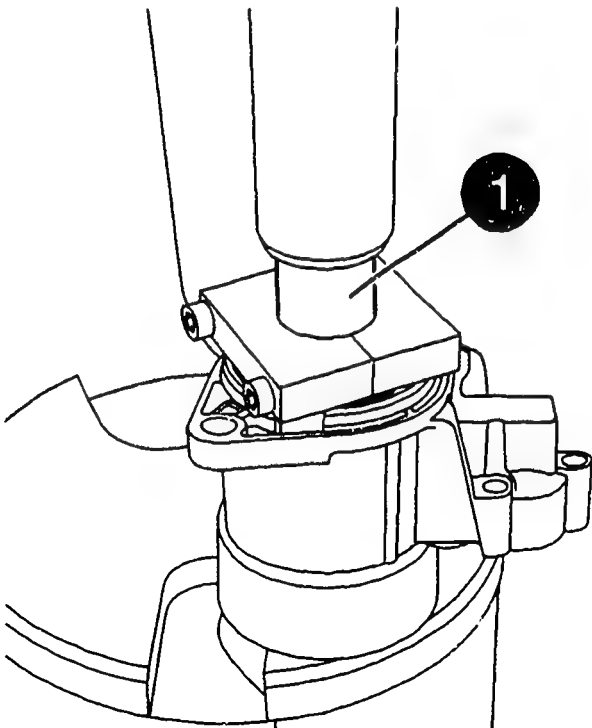
Assembling thrust ring  
(pinion with 10 teeth)

**ATTENTION:** Always pay attention to pressing-on instructions. Use pressing-on tool (1) and mandrel press to carefully press on thrust ring. Check firmness of thrust ring several times. Remove pressing-on tool and holder and check correct position of thrust ring again.

Mandrel press:	comm. avail.
Pressing-on tool for pinion with 10 teeth:	0 986 619 405

Continue: III18/1 Fig.: IV09/2

KMS00442



## STARTING MOTOR ASSEMBLY

### Assembling armature

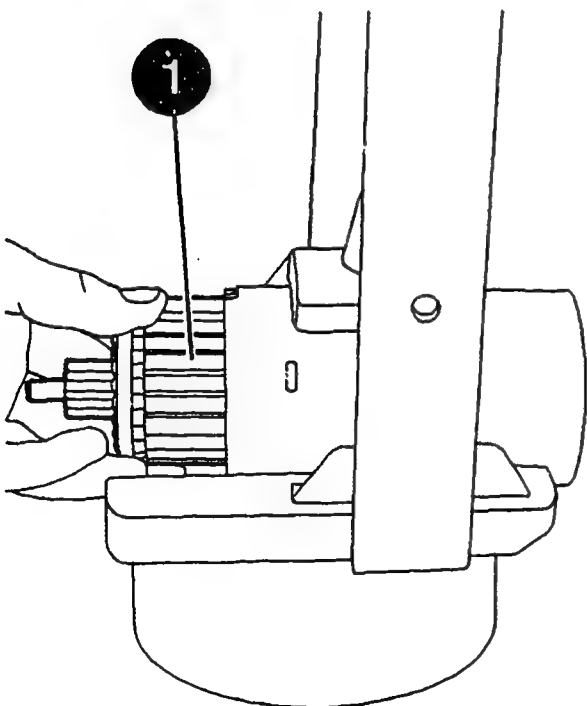
Clamp stator frame in clamping support.  
Insert armature (1) from drive-end bearing side into stator frame until armature shaft is positioned in hole of locating sleeve in brush holder.

**ATTENTION:** The armature is attracted by the stator frame due to the exciter magnetic field.

Clamping support: 0 986 619 362

Continue: IV11/1 Fig.: IV10/2

KMS00443



## STARTING MOTOR ASSEMBLY

### Assembling armature

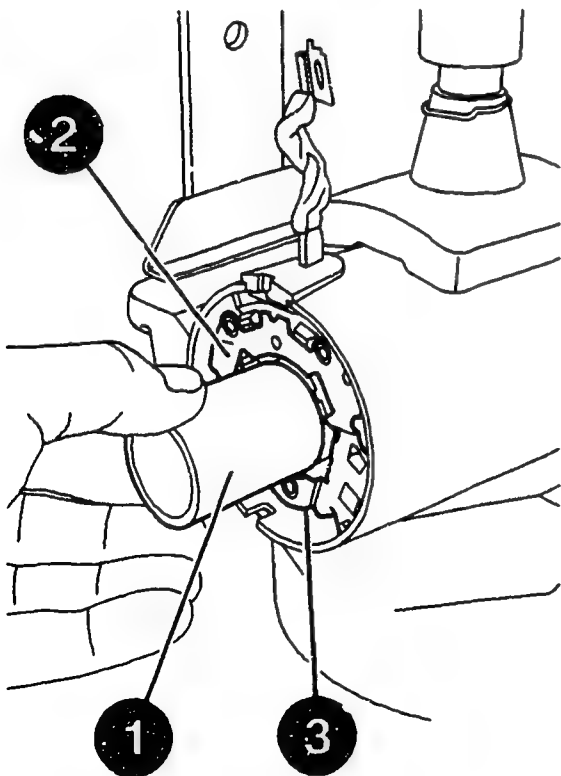
Push armature further in and at the same time pull locating sleeve (1) out of brush holder (2).

The carbon brushes must rest on the commutator.

Pay attention to correct positioning of locking element (3) in stator frame.

Continue: III18/1 Fig.: IV11/2

KMS00444



## STARTING MOTOR ASSEMBLY

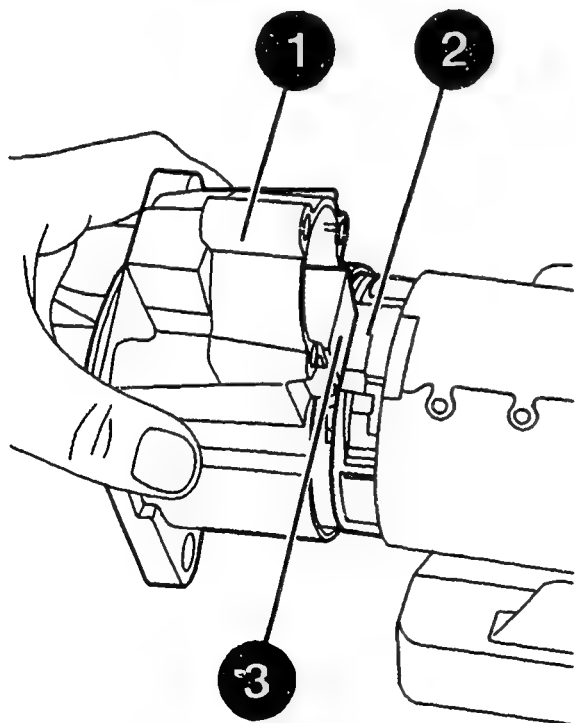
### Assembling drive-end bearing

Remove pre-assembled drive-end bearing from assembly stand (9 teeth) or from support sleeve (10 teeth). Insert rubber seal (3) at mount of engaging lever and insert planetary gear train (2) in stator frame whilst supporting brush holder.

Turning drive-end bearing unit (1) slightly facilitates meshing of sun gear in planet gears. Pay attention to correct positioning of rubber seal (3) in stator frame and drive-end bearing.

Continue: III18/1 Fig.: IV12/2

KMS00446





## STARTING MOTOR ASSEMBLY

### Assembling commutator end shield

Position commutator end shield (2) on stator frame. Pay attention to correct positioning of end shield and gasket (3).

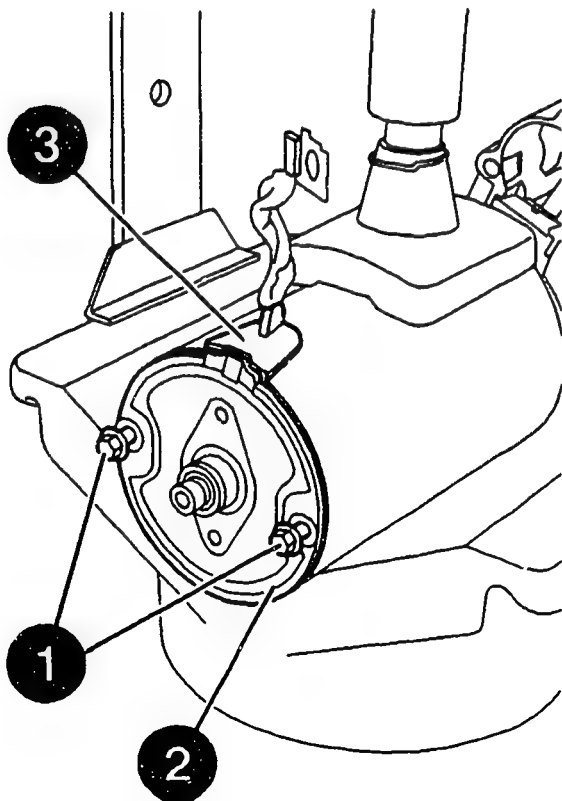
Slacken off clamping support, re-check positioning of drive-end bearing and secure bolts (1). Bolts must run in parallel with imaginary center axis of starting motor. Use torque wrench.

Torque wrench: comm. avail.

Tightening torque: 5,5...6,0 Nm

Continue: IV14/1 Fig.: IV13/2

KMS00400

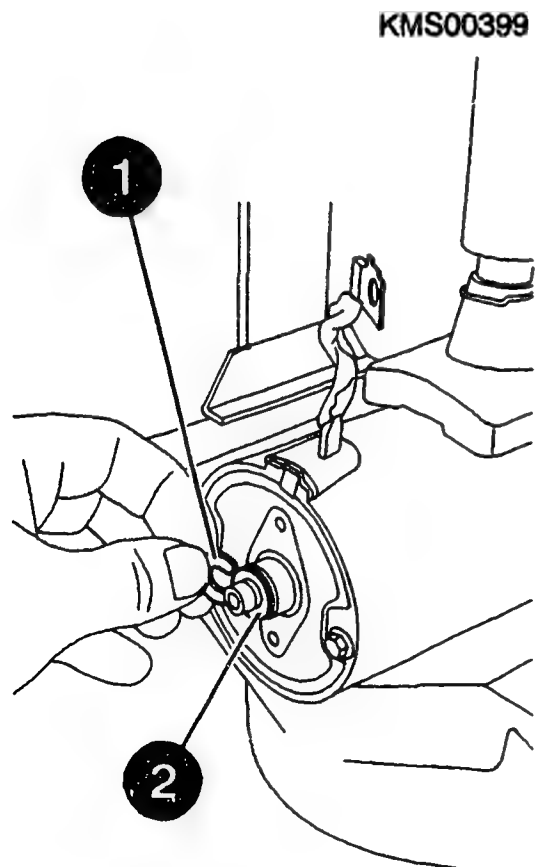


## STARTING MOTOR ASSEMBLY

### Assembling commutator end shield

Slip new shim (2) onto armature shaft and insert positioning washer (1) in annular groove.

Continue: III18/1 Fig.: IV14/2



## STARTING MOTOR ASSEMBLY

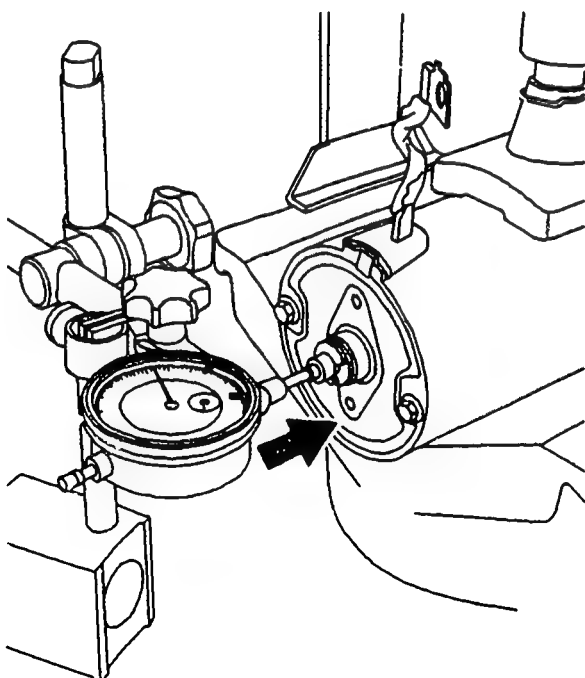
### Checking and adjusting armature axial clearance

Push in armature as far as it will go in direction of drive-end bearing (arrow).

Apply dial gauge at end face of armature shaft and set it to "ZERO".

Continue: IV16/1 Fig.: IV15/2

KMS00447



## STARTING MOTOR ASSEMBLY

### Checking and adjusting armature axial clearance

Move armature in direction of commutator end shield as far as it will go, read off armature axial clearance.

If armature axial clearance is outside stated range, adjustment must be made using an appropriate shim.

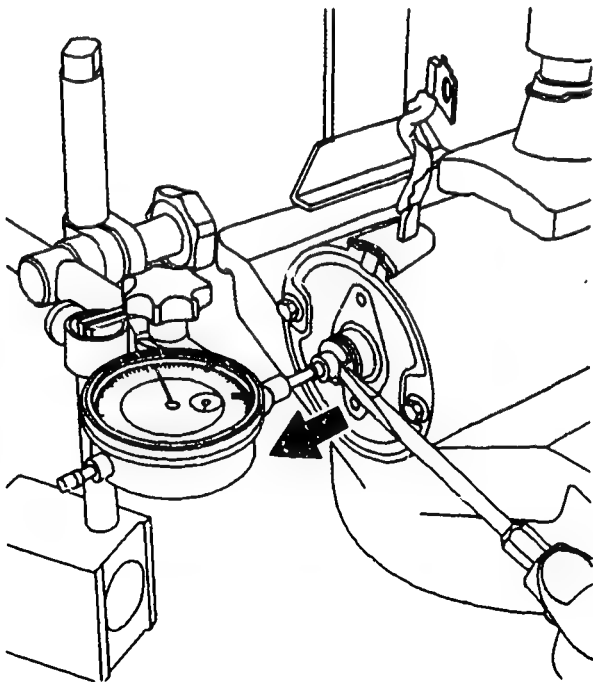
Then check armature axial clearance again.

Check freedom of movement of armature.

Armature axial clearance: 0,2...0,75 mm

Continue: III18/1 Fig.: IV16/2

KMS00448



## STARTING MOTOR ASSEMBLY

### Assembling bearing end plate

Slip new gasket (1) onto commutator end shield.

Fill 1/3 of bearing end plate (2) with grease and secure.

Use torque wrench.

Torque wrench:

comm. avail.

Grease VS 18036 Ft:

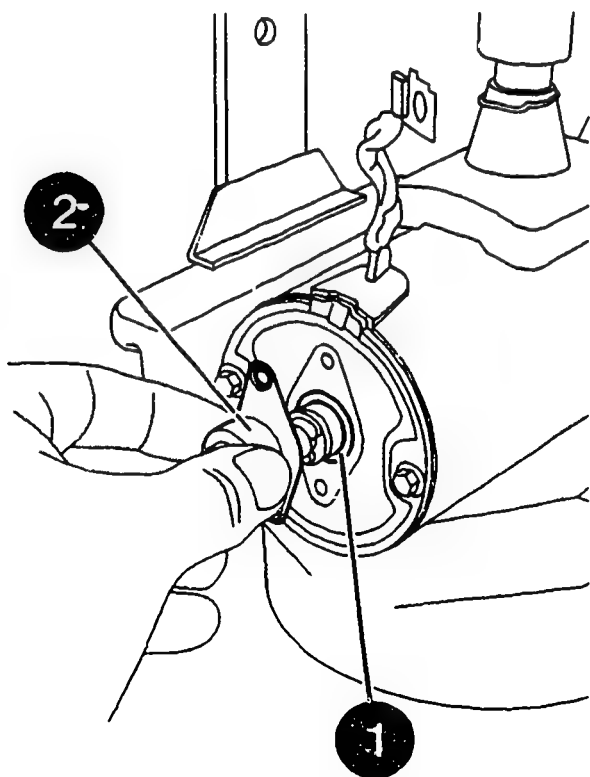
5 997 098 000

Tightening torque:

1,5...2,0 Nm

Continue: III18/2 Fig.: IV17/2

KMS00449



## STARTING MOTOR ASSEMBLY

### Checking armature braking torque

Insert bolt (1) or the like in pinion to guarantee correct positioning of torque meter.

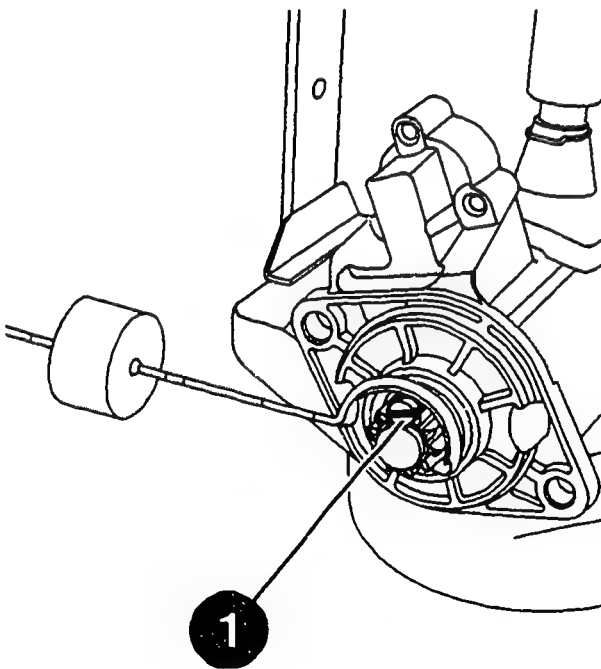
Suspend torque meter from pinion in line with direction of operation of starting motor and move to horizontal position. Shift weight. Pinion may only start to turn as of mark "7".

Torque meter: 0 986 617 206

Armature braking torque: 0,7...1,2 Nm

Continue: IV19/1 Fig.: IV18/2

KMS00451



## STARTING MOTOR ASSEMBLY

### Checking armature braking torque

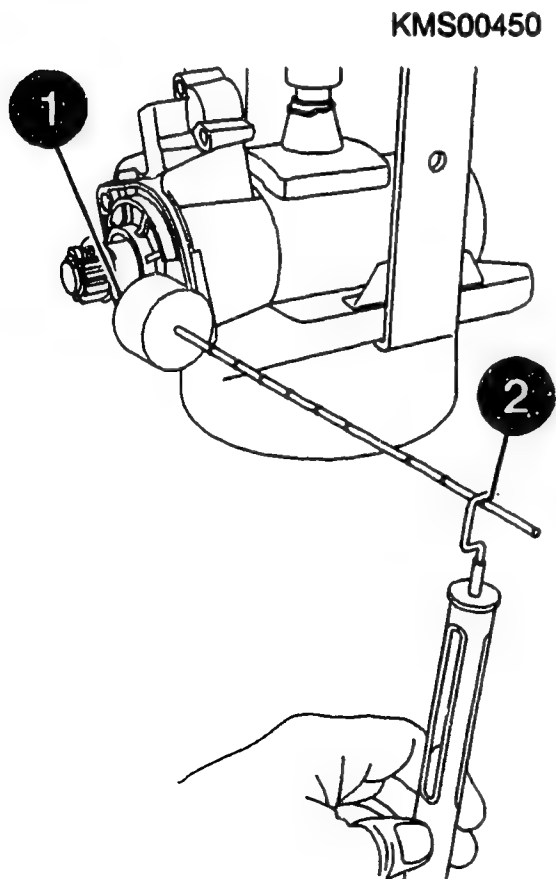
Proceed as follows if the torque applied with the torque meter is not sufficient to overcome the armature braking torque:

Move weight to second mark "2.0" (1).  
Suspend spring balance at last mark "8" (2).

Spring balance:

0 986 619 181

Continue: IV20/1 Fig.: IV19/2



## STARTING MOTOR ASSEMBLY

### Checking armature braking torque

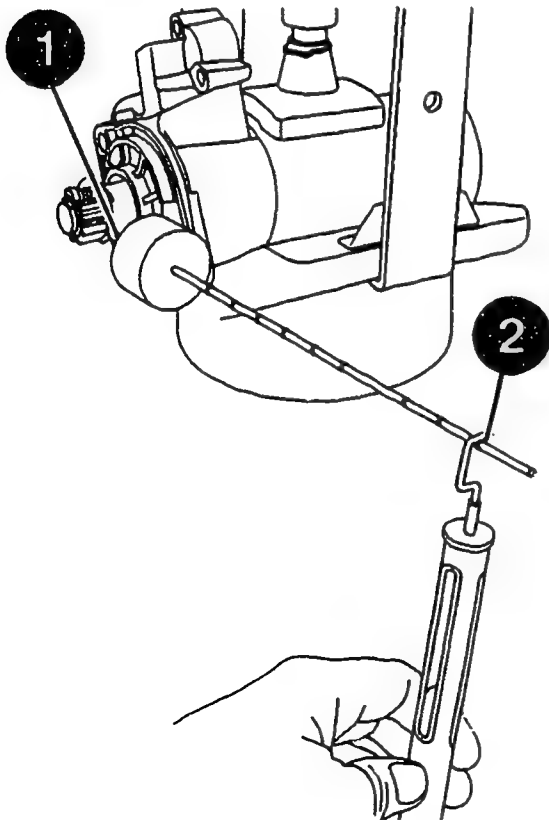
Pull on spring balance until pinion with armature starts to rotate.  
Take spring-balance scale reading.  
Reading must be between  
0,21...0,35 kg, corresponding to a  
tensile force of 2,0...3,4 N.

The armature braking torque is then  
within the required range. Otherwise,  
check components and component  
assembly.

Armature braking torque: 0,7...1,2 Nm

Continue: III18/2 Fig.: IV20/2

KMS00450





## STARTING MOTOR ASSEMBLY

### Checking clutch overrunning torque

Insert bolt (1) or the like in pinion to guarantee proper attachment of torque meter.

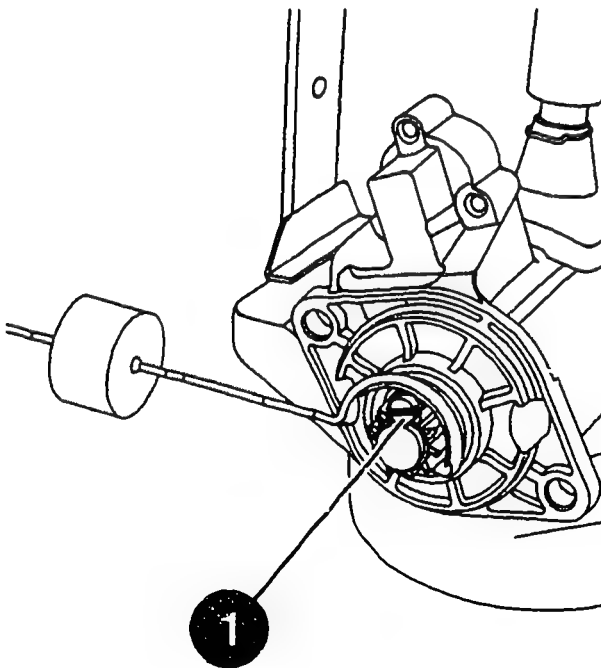
Suspend torque meter from pinion in line with direction of operation of starting motor and move to horizontal position.

Torque meter:

0 986 617 206

Continue: IV22/1 Fig.: IV21/2

KMS00451



## STARTING MOTOR ASSEMBLY

### Checking clutch overrunning torque

Shift weight until pinion starts to rotate. The scale reading must be between "1,0"... "2,0", corresponding to an overrunning torque of 0,1...0,2 Nm.

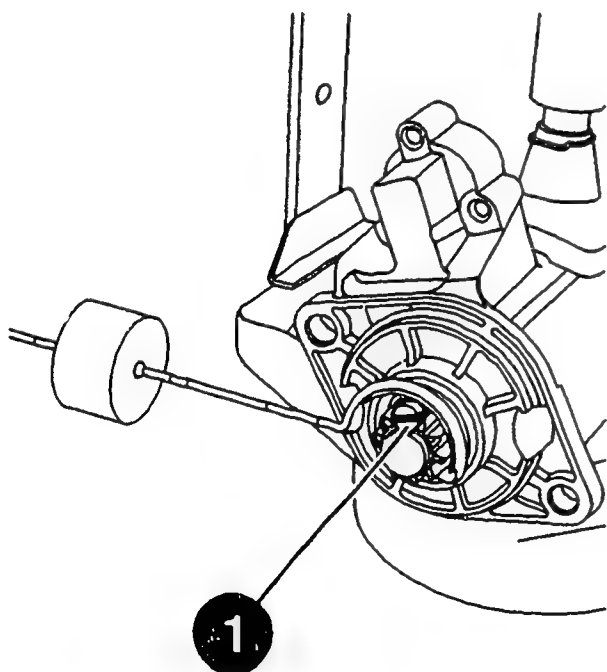
**ATTENTION:** Torque meter must not make contact with drive-end bearing during test.

Clutch overrunning torque:

0,1...0,2 Nm

Continue: III18/2 Fig.: IV22/2

KMS00451



# STARTING MOTOR ASSEMBLY

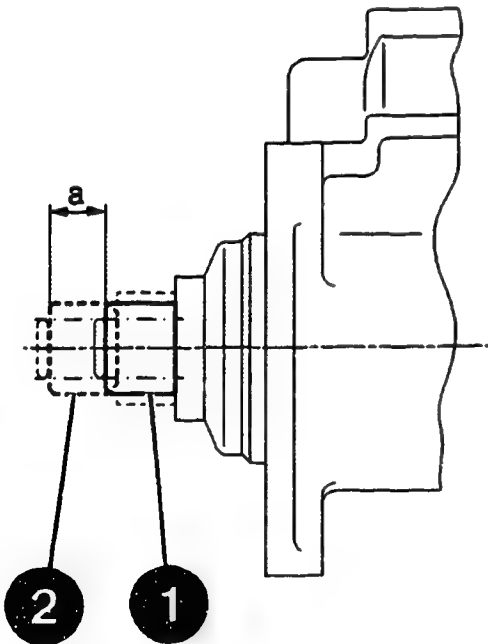
## Checking total pinion travel

The total pinion travel is to be measured at the end face of the pinion between rest position (1) and end position (2) (fully meshed).

Vernier caliper: comm. avail.  
Total pinion travel a: 12...15 mm

Continue: III18/2 Fig.: IV23/2

KMS00452



## STARTING MOTOR ASSEMBLY

### Assembling solenoid switch

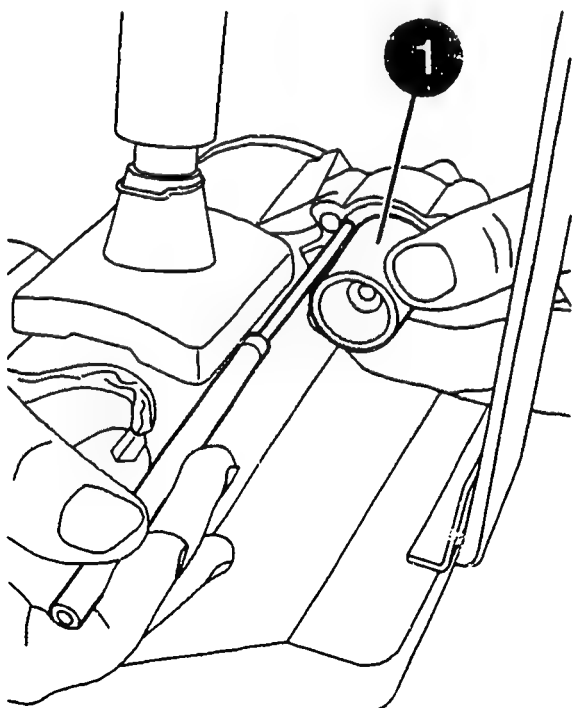
Use suitable tool to pull back engaging lever and engage solenoid switch armature (1) in engaging lever.

Apply small quantity of grease to periphery of switch armature. Pay attention to return spring in solenoid switch armature.

Grease VS 16634-Ft: 5 990 260 000

Continue: IV25/1 Fig.: IV24/2

KMS00397



## STARTING MOTOR ASSEMBLY

### Assembling solenoid switch

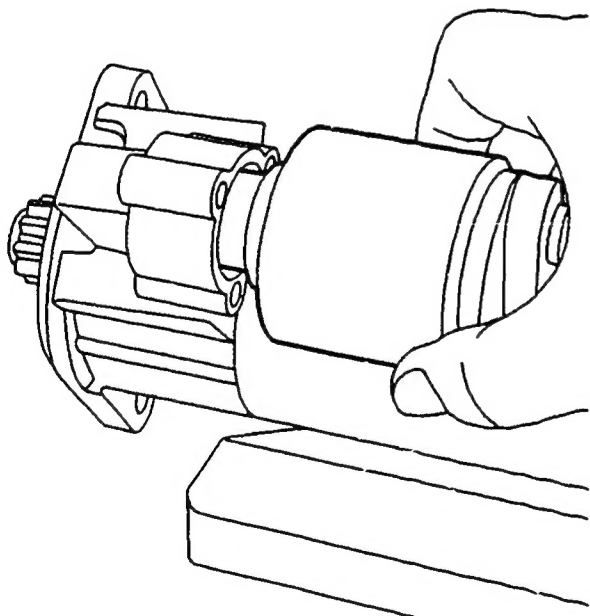
Slip on solenoid switch and attach to drive-end bearing.  
Make sure return spring is properly positioned in solenoid switch.  
Pay attention to mark.  
Use torque wrench.  
Apply approx. 0.5 g of Loctite 577 (5 994 090 000) to threads of bolts.

Torque wrench: comm. avail.

Tightening torque: 4,5...6,0 Nm

Continue: IV26/1 Fig.: IV25/2

KMS00396



## STARTING MOTOR ASSEMBLY

### Assembling solenoid switch

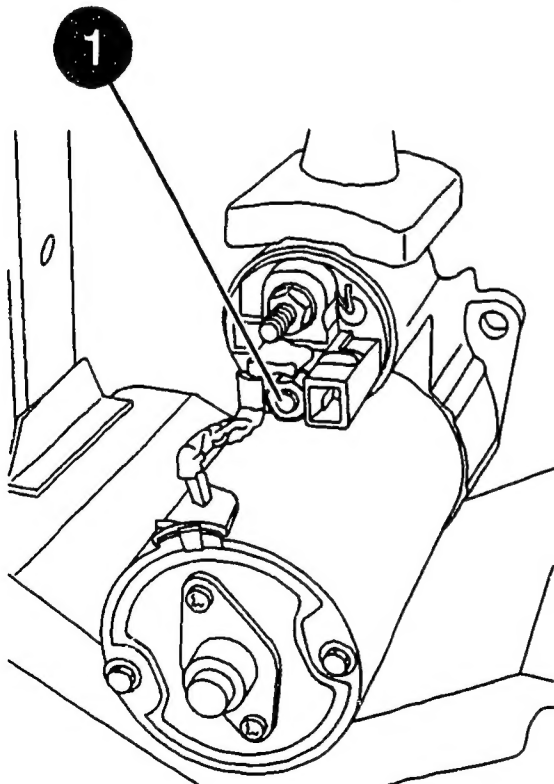
Attach connection of brush holder (1)  
to solenoid switch, terminal 45.  
Use torque wrench.

Torque wrench: comm. avail.

Tightening torque,  
term. 45: 7...9 Nm

Continue: III18/2 Fig.: IV26/2

KMS00395



## STARTING MOTOR ASSEMBLY

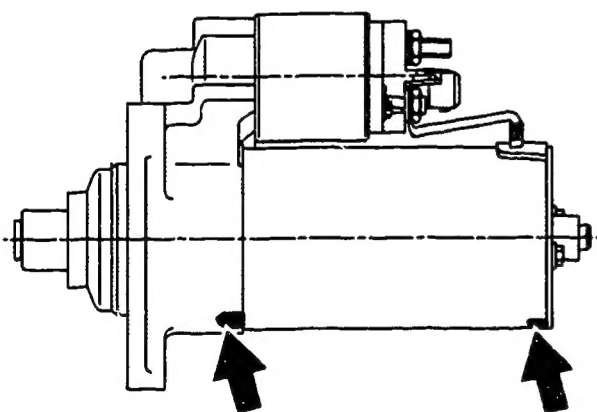
### Painting starting motor

If starting motor is painted after assembly, make sure that paint does not ingress into the interior of the starting motor through the vent holes (see arrows) in the stator frame and drive-end bearing.

Seal off vent holes before painting. Always re-open vent holes after painting so as to ensure proper functioning of starting motor.

Continue: III18/2 Fig.: IV27/2

KMS00453



**EDITORIAL NOTE**

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